Vol. XXVIII. PUBLISHED MONTHLY. No. 3.

The Journal
OF THE
Ministry of Agriculture

JUNE, 1921.

PRINCIPAL CONTENTS.

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LONDON:
PRINTED UNDER THE AUTHORITY OF HIS MAJESTY'S STATIONERY OFFICE,
AND PUBLISHED BY THE MINISTRY OF AGRICULTURE AND FISHERIES.

(To be obtained from the Ministry's Offices, 10, Whitehall Place London, S.W.1.)

EDITORIAL AND PUBLISHING OFFICES:
10, WHITEHALL PLACE,
LONDON, S.W.1.

MONTHLY.
[PRICE SIXPENCE.]
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Report on the Occurrence of Insect and Fungus Pests on Plants in England and Wales in the Year 1919.

THE present report is arranged on much the same plan as previous reports. It contains the first published *complete* list of the fungus diseases found on Plants in England and Wales.

The report is intended primarily for those engaged in work upon the pests of cultivated plants, whether grown on the farm, in the orchard, or in the garden, but it will also be of value to every grower who is anxious to know more of the subject than can be given in leaflet form. As a reference work the present report should prove of special value to all interested in fungi whether from the disease aspect or not.

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Past Issues of the Journal and Journal Supplements.

THE Ministry desires to announce that a number of copies of past issues of this JOURNAL (from Vol. I onwards) and of JOURNAL SUPPLEMENTS are now available. Full particulars will be found on p. 281 of this number.

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THE JOURNAL
OF THE
MINISTRY OF AGRICULTURE

Vol. XXVIII. No. 3.

JUNE, 1921.

NOTES FOR THE MONTH.

Home-Grown Wheat Prices for June, 1921.

In the May issue of this Journal, particulars were given of the arrangements made as regards the price of home-grown wheat of the 1920 crop, and it was stated that for the month of May the average price properly receivable by growers was 92s. per 504 lb.

The Ministry is now informed that the Royal Commission on Wheat Supplies calculate that the cost of wheat imported during March, April and May was equivalent to 86s. 7d. per quarter of 504 lb. for home-grown wheat of sound milling quality. For the month of June, 1921, therefore, the average price properly receivable by growers for home-grown wheat of sound milling quality will be 86s. 7d. per 504 lb.

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The Movement towards Live Stock Improvement.

For the present financial year (1921-1922) it has been found possible to allocate a sum of £35,000 for the continuance of the Ministry's scheme for the improvement of live-stock. Of this amount £18,000 is set aside for grants for the provision of high-class pedigree bulls, £7,250 for heavy horses, £3,000 for boars, and £7,800 for milk recording societies. The provision covers grants for 900 bulls, 600 boars, 100 heavy horses and for a few rams which will be used in North Wales, this last being a comparatively new experiment.

The value of the grants is very considerable both directly and indirectly. The direct result of increasing the number of high-class pedigree sires available for the smaller farmer is in itself satisfactory, but the fact that for every sire so located a number of farmers varying from 10 upwards are receiving a practical

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demonstration of the advantage of good breeding is equally valuable. As a result of the Ministry's Live Stock Scheme many breeders have purchased pedigree cows and heifers to mate with the premium bulls, and not a few members of milk recording societies have become owners of good class bulls of milking strains. The scheme has led also to the establishment of several new herds of pedigree shorthorns in various parts of the country. It is this change in the attitude of formerly indifferent farmers toward the question of good breeding that constitutes one of the most satisfactory features of the progress which the scheme has effected. As an indirect result of the movement towards pedigree which has arisen out of the scheme is the formation of several new breed societies, with consequent improvement both in the quality of the animals and in the prices realised for them. It is significant too that, during the period when the slaughter of calves was at its height, few calves sired by premium bulls went for slaughter. It was clear that those who had bred a good calf were not disposed to see it turned into veal. The mere fact that it had good parentage was sufficient justification for an effort to rear it.

There has been considerable appreciation in the value of the pedigree animals used under the scheme, and in their progeny, and although the sires have in many cases been bought in the first instance at comparatively low figures their value has risen very considerably as soon as their quality is proved. For example, a boar bought for twenty guineas under the Live Stock Improvement Scheme was sold some time later for six hundred, while a premium bull sold for service in a pedigree herd sired nine bull calves which averaged upwards of five hundred guineas apiece. It is reported from one farm that the calves bred from a premium bull made £10 more per head than others bred on the same farm from another sire. In one instance a bull bought under the scheme for £240 was sold for 550 guineas to go abroad, while another that cost 43 guineas under the scheme ultimately reached the Argentine where it fetched 550 guineas. The owner of one of the premium bulls won first prize at the Royal Norfolk Show and has refused £250 for the animal. At the same time it is noticed that service fees are much higher than they were, and are paid without complaint for the use of premium sires.

In addition to the financial assistance afforded to farmers under the Ministry's Live Stock Improvement Scheme the

services of the Ministry's Live Stock Officers are at their disposal, and the advice which is increasingly sought is evidence of the gradual penetration of the scheme into districts where the need for live stock improvement is greatest.

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The Progress of Milk Recording.

THE Ministry's Milk Recording Scheme was handicapped in its initial stages by the War, and progress was at first necessarily slow. During the year 1916-17 nearly 13,000 cows were recorded in England and Wales. In the following year the number increased to 20,000, a year later to 38,000, and last year to 60,000. The number at present being recorded is over 85,000, and there will undoubtedly be a still further increase during the present year. In one county the Milk Recording Society has increased from 19 members with 20 herds in 1914 to 83 members with 88 herds at the present time.

The rapid progress now being made is due to the growing appreciation of the advantages to be gained by milk recording. The initial expense and the trouble involved, which made many farmers reluctant to adopt the practice, have been proved by those who were wise enough to give the system a trial, to be well worth while. By keeping milk records the farmer knows just what his cows are yielding, and can ensure that he keeps no cow that does not earn her keep. The variation in the value of the milk produced per cow in different herds is very striking. From figures available for the year 1919-20 it was seen that the average cow in the *best* herd gave £66 worth of milk (valued at 1s. 6d. per gallon). The average cow in the *average* herd yielded £47 worth of milk, and the average cow in the *poorest* herd only £37 worth Figures like these bring home to the farmer the desirability of ascertaining the milking capabilities of his cows, which, moreover, he can have officially certified by the Ministry if his records have been carried out in accordance with the Ministry's regulations.

Certificates of milk yield are issued by the Ministry for milk recorded cows, and give, in addition to the milk yield of the cow, her summarised history for the period covered by the certificates. These certificates have had a remarkable effect on the prices realised at sales of recorded cows. As much as £285 was paid last year for a *non-pedigree* cow with

an officially certified milk record, and it is evidence of the farmers' recognition of the practical value of the certificate that while 640 certificates were applied for in 1916 the number applied for in 1920 was nearly 18,000. It is noteworthy too, that of the cows whose yields were certified by the Ministry last year, 800 gave over 1,000 gallons each and two very exceptional animals 2,000 gallons each.

Although the rate of progress now being made cannot be considered as otherwise than satisfactory, milk recording is by no means as generally adopted as it should be, and in order to encourage the formation of new Societies or the development of existing ones the Ministry makes grants towards the expenses of a Society provided it complies with the Ministry's Regulations. These grants are based on the number of herds in the Society, and amount to £3 10s. per herd per annum for a new member and £3 for a member who has been recording under the Ministry's Scheme for over two years. The total grant payable to a Society may not exceed one-half its expenses for the milk recording year.

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Need for a More General Use of Improved Varieties of Seed.

IN the Agricultural Statistics (Part II) which have recently been issued, attention is drawn to the fact that during the past 35 years no appreciable increase can be traced in the average yield per acre of the principal crops in England and Wales. The returns for individual years are so affected by weather conditions that no conclusions can be drawn by comparing one year with another, but over longer periods unfavourable seasons tend to be balanced by those more blessed by nature, and by comparing the average yield of crops over fairly long periods the influence of the weather can be more or less eliminated.

Taking the average yields over periods of fifteen years, the changes during the past 35 years are small and irregular, and there is practically no indication of any real or substantial change in the average rate of production of the most important crops. In the case of wheat there is some small evidence of a higher yield which may be due to the increased attention which has been given in recent years to improved varieties of seed, though it is not safe to assume that the rather larger yields obtained in the later years are attributable to improved methods of cultivation. The latter, taking the country as a whole, have probably not changed sufficiently to affect the

average production though the more general introduction of heavier cropping varieties must have tended to raise the average yield. It is undoubtedly in this direction that greater returns must be looked for in the future. When it is remembered that many of the newer varieties give yields under favourable conditions of from 40 to 60 bushels per acre, it will be seen that, even allowing for variations in soil, a substantial increase in the average production might be obtained if these varieties were more generally sown. Even an increase in the average yield from 31½ to 33 bushels per acre would mean a total additional production approaching 400,000 quarters, and would often determine the question of profit or loss to the individual farmer.

There has been practically no increase in the average yield of barley, oats, or peas, though in the case of these crops equally with wheat, much higher yields could undoubtedly be obtained by the more general use of improved varieties. In the case of potatoes the average yield during the past 15 years has been about one-fifth of a ton more than in the preceding 20 years. This may conceivably be due to a more general use of seed potatoes grown in another district.

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Importation of Cattle: Royal Commission.

IT was announced in the House of Commons on May 2nd that a Royal Commission had been appointed—

> "To inquire into the admission into the United Kingdom of live-stock for purposes other than immediate slaughter at the ports, whether such action would increase and cheapen the meat supply of the country, and, if so, to what extent, and whether it is advisable, having regard to the necessity of protecting live-stock bred in the country from the introduction of disease, and of restoring their numbers after the losses to which they were subjected during the War."

The members of the Commission are as follows:—

Lord Finlay (*Chairman*),
Lord Askwith,
Sir Algernon Firth,
Sir Harry Peat, and
Sir Arthur Shipley.

* * * * * *

Minimum Prices of Wheat and Oats Harvested in 1921.

THE attention of farmers is again drawn to the fact that in order to obtain the benefit of the guarantee under the Agriculture Act, 1920, in regard to the minimum prices of wheat and oats, a claim must be made in respect of the area on which the wheat or oats are grown in 1921. Forms of claim for 1921 will be issued along with the forms on which the Agricultural Returns have to be made on 4th June, 1921. The claims must be forwarded direct to the Ministry of Agriculture and Fisheries not later than the 30th June, unless the claimant can show that he became the occupier of the land after that date, in which case the Minister may accept a claim made not later than the 1st September, 1921.

The claimant will be required to enter on the form of claim particulars of each separate field of wheat or oats. The number of each field as shown on the 25-inch Ordnance Survey Map, and the ploughed area of wheat or oats in each field, will have to be stated. These detailed particulars are necessary to enable the Ministry and the County Agricultural Committee to verify the accuracy of the claim. Farmers are advised to take steps forthwith to ascertain the numbers as shown on the 25-inch Ordnance Survey Map of the fields sown with wheat or oats.

Copies of the Ordnance Survey Map and the 25-inch scale can be purchased through any bookseller, price 5s. per sheet. In most districts copies of the map of the district can be inspected at the office of the County Agricultural Committee. Information as to the number of fields can also be obtained at the local office of the District Valuer of the Board of Inland Revenue; the Clerk of the Rural District Council and the Assistant Overseer may also possess copies of the Ordnance Survey Maps of their respective districts. In case of difficulty inquiry should be made of the Cultivation Officer of the County Agricultural Committee.

A concise statement of the provisions of the Agriculture Act in regard to these minimum prices will be found in the JOURNAL for April last, p. 8.

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Annual Returns of Crops and Live Stock.

THE Ministry desires to remind farmers that the Annual Returns of the acreage under crops, and numbers of live stock will be collected on 4th June. The schedules were issued to occupiers of agricultural holdings at the end of May, and should be completed and returned at

once to the Crop Reporter for the district whose name and address appear on the back of the schedule. The particulars asked for include the acreage of crops and the numbers of live stock and poultry on the holding on 4th June. The numbers of men and women employed on each holding must also be given.

It is of great importance to farmers themselves that the statistical information in regard to the agricultural industry should be as complete and as accurate as practicable, and farmers are urged to endeavour to fill up the schedules correctly after studying the detailed instructions given in the form. The returns should be furnished promptly. A summary of the figures for the whole country will be issued at the beginning of August.

THE NEED FOR LIME AND HOW TO MEET IT.

B. H. BEDELL.

BEFORE the general use of artificials enabled the farmer to forget for a time his ancient friend the lime kiln, he had limed not always wisely but frequently too well, with the result that such stores of lime were laid up in the soil that many fields to-day owe much of their fertility to excessive dressings of lime applied perhaps forty years ago. This happy state of affairs is, however, becoming more and more rare as the years succeed one another and no lime is returned to the soil to replace the inevitable losses. It has been computed that to meet the lime requirements of the arable land only in England and Wales, 3½ million tons of burnt lime would be needed, and that the losses due to all causes on this same land do not fall far short of 800,000 tons a year. As it is improbable that more than 350,000 tons are applied annually it is not difficult to see that we are heading straight for national lime bankruptcy. In fact a time is approaching, and on some farms has already arrived, when no amount of artificial manure can restore loss of fertility due to soil acidity which only lime in some form can correct.

The writer feels, therefore, that no apology is needed for drawing attention to some of the considerations incidental to the production of lime to meet this urgent need.

There are two forms in which lime may be applied to the soil, neglecting unessential modifications. The first of these is burnt lime, and the second is ground limestone (or ground chalk), and each of these can be obtained by the farmer in two ways; he can either buy them, or if his land overlies a chalk or limestone formation, he can produce them himself. At the present time there is a feeling among agriculturists that lime producers are demanding much more profit than they are economically entitled to, or than the increased costs of production warrant. The writer believes that this feeling is by no means always justified by the facts, but where it is well founded, the purchasers (either individually or collectively as a co-operative society) might think well of adopting the second alternative and eliminate the producer's profit altogether by providing their own lime. With this possibility in view, it is proposed to offer a few suggestions as to the plant required and the processes involved, first in the production of ground limestone (or chalk) and secondly in burning these materials to obtain quick lime.

The Stone.—The first consideration is obviously the discovery of a bed or outcrop of limestone of suitable composition upon the estate or near enough to it, to make haulage not too serious an item. All the Upper Chalk is entirely suitable for burning and for grinding; the Lower, or Grey Chalk is by no means so good, and often contains so much combined silica that when burnt it forms a strongly hydraulic lime of doubtful use to the agriculturist. Limestones offer a much wider range of texture and chemical composition than chalk, and before any decision is arrived at with regard to grinding or burning a limestone, samples should be analysed. It may be decided at once that any stone which contains over 92 per cent. of calcium carbonate ($CaCO_3$) is suitable either burnt or ground. Many rocks which fall far short of this percentage of calcium carbonate are also good, but a little consideration of their other constituents is necessary before deciding upon their use.

Magnesian Limestone.—Many deposits of limestone, some of them of considerable extent, and consequently of importance, contain the element Magnesium in varying proportions. Magnesium has a close chemical relationship to calcium, and also occurs in limestone in the form of a carbonate. Magnesium carbonate ($MgCO_3$) is met with in all proportions from mere traces up to 45 per cent., at which point it is in chemically equivalent proportion to the calcium carbonate; such limestones containing a high proportion of magnesium carbonate are termed Dolomites.

There has been much controversy as to whether, to what extent, and in what circumstances dolomitic limestones are injurious to plant growth when applied to soils either before or after burning. Trials have shown that an excess of magnesia in a soil has a toxic action on crops, but the extent of such action depends on the type of soil, the condition of the soil, and particularly on the amount of lime present in the soil with the magnesia. It may, however, be safely assumed that a stone containing up to 10 per cent. of magnesium carbonate can always be used on any soil; higher proportions of magnesium carbonate should be regarded with some suspicion where it is intended to apply the ground stone to land already heavily charged with magnesia.* Ground limestone has been particularly mentioned, for where we are dealing with burnt lime made from dolomitic limestone, we are faced with a new source of danger not connected with any toxic action of the magnesia,

* Further information on the use of Lime or Limestone rich in Magnesia will be found in Leaflet No. 170, p. 13.

but arising from the fact that magnesian lime always takes longer to slake and revert to carbonate than a straight calcium lime, and sometimes takes so long that the soil remains partially sterile for months after it is applied. This "burning" effect is particularly noticeable on light soils.

When therefore dolomitic limestone is under consideration, our conclusions will be very largely dependent upon whether the stone is to be ground or burnt; if the former, we shall probably decide to use it, making a mental note that we would rather it had been straight calcium limestone, but if lime is to be made from it then we shall proceed with the utmost caution, getting a few tons burnt in a clamp or a neighbouring lime kiln as an experiment, and testing the lime before embarking on kiln building and quarry plant.

Before leaving this thorny question of the magnesia content of the stone, there is one other point on which much misunderstanding exists, which it may be useful to discuss. The calcium carbonate content of a Dolomite is frequently spoken of as though that alone could have an agricultural value; this is quite erroneous, for the magnesium carbonate is also capable of neutralising soil acidity, and from this point of view a stone analysing 59 per cent. of calcium carbonate ($CaCO_3$) and 39 per cent. of magnesium carbonate ($MgCO_3$) is not a 59 per cent. limestone but a 98 per cent., neglecting its somewhat slower action, and the possible toxic effect on certain soils.

Another impurity frequently met with in limestone is combined silica, which can have no toxic effect, but in both the ground and the burnt stone it is not only an adulterant but withdraws an equivalent amount of the calcium present from taking an effective part in soil neutralisation. Other impurities likely to be met with are iron, uncombined silica, and organic and earthy matters, none of which need be considered as they are only diluents, and usually occur in quantities too small to be of much importance.

Method of Utilisation.—Having found and analysed the stone we must decide whether it will be better to reduce it to powder in a mill, or to burn it to quick-lime in a kiln. If the limestone contains a high percentage of calcium and the distance over which it will have to be drawn is great, and providing there is an ample supply of coal and wood readily available, then burning the stone is clearly the right thing; on the other hand a Dolomite is usually better applied to the soil as ground stone. Between these extremes there are a great number of intermediate cases which must be decided on their merits.

In comparing the two products it must always be borne in mind that one ton of quick-lime is the equivalent of a little more than $1\frac{3}{4}$ tons of ground limestone, and that consequently, in cases where a long " draw " is involved, there may be ample compensation for the additional quantity of coal consumed in burning, instead of grinding the stone. This consideration brings us to the question of the relative fuel costs involved in the two cases. To supply the answer in any specific case it would be necessary to know all the conditions, but the following information will be found useful in arriving at a just comparison.

In the average small pot kiln, lime can usually be burnt with an expenditure of from 7 to 10 cwt. of culm per ton of lime produced. In small draw kilns, where the heat losses are considerably lessened by the continuous nature of the process, a fuel consumption of 5 to 7 cwt. of coal per ton of lime may be anticipated, and in large draw kilns as little as 4 cwt. of coal is sometimes used. On the other hand, to grind one ton of chalk or limestone will require about 8-10 horse-power-hours, corresponding to the consumption of 40-50 lb. of coal in an average farm steam engine or of $\frac{3}{4}$ gallons of paraffin if an oil engine is used to drive the mill.

Although nearly double as much ground stone must be produced in order to be equivalent to the lime, it will be seen that so far as fuel alone is concerned, there is great saving in cost when the stone is ground instead of burnt. If the question is worked out on the present prices of oil and coal the above figures will show that for fuel alone, burnt lime will cost about 16s. a ton, while the equivalent $1\frac{3}{4}$ tons of ground stone will cost only about 2s. 6d. for power fuel. Running costs and the first capital cost of the installation, however, will generally be slightly in favour of the kiln. The comparative cost of two equivalent plants, one to burn lime and the other to grind stone, both on a very small scale, would be in the ratio of about 1:3 – in favour of the kiln. More skill in manipulation and greater previous experience are needed in the case of the kiln than in that of the grinding plant.

Assuming that the choice of process has been made, we will now consider matters connected with limestone grinding plants of small size, such as many farmers could easily instal.

Small Grinding Plants.—The object of all agricultural stone grinding plant is to produce ground stone or chalk in a sufficiently fine state of sub-division to enable it to react readily

with the constituents of the soil and dissolve; hence it is important to know how small the particles of stone must be in order that their function may be fulfilled. If the stone were all reduced to impalpable dust, the object would be attained; this is, however, far from being a practicable proposition, on the ground of both initial and running costs. We have, therefore, to decide, not what is absolutely the best, but what is fine enough to give thoroughly satisfactory results in practice. Not all authorities are agreed on the point of fineness in grinding, but there is a very general belief that a fair mean is struck between the ideal and the commercially practicable, when nearly all the ground stone will pass through a screen having ten meshes to the linear inch, and all the fine material produced in grinding is included. This product contains about 10 to 15 per cent. of stone which is in too coarse a state of sub-division to be immediately useful, but the reason it is recommended is that the type of mill which will produce it is much cheaper, and the power required to drive the mill is so much less than for a similar output of finely ground stone, that there is no doubt about the advantages attaching to the rougher method.

Experiments have been conducted both in this country and in America in order to ascertain what is the actual size of grain below which no appreciable improvement in fertilising value can be detected. Although opinions differ it seems that particles which pass through a 60×60 screen are at any rate fine enough for all practical purposes. It might at first seem that ground stone passing through a 10×10 screen would not be fine enough to be of very much service; such a material, however, would be found in general to contain about 70 per cent. small enough to pass through the 60 × 60 screen. This is a fact not infrequently overlooked by producers of very finely ground but very highly priced agricultural limestone. In the matter of distribution there is an actual advantage attaching to the more coarsely ground product, for it does not tend to clog and hang together like the very fine limestone dust, and for that reason gives much less trouble in the distributor.

The plant necessary to produce this comparatively coarsely ground limestone is so compact and simple that it is possible to mount it in portable form so that it can be drawn by a tractor to any point where it can be fed conveniently with broken stone. A tractor or other portable source of power can be used to drive it. There are many makes of machine, but the Disintegrator is the only type of mill which can be used

to fulfil these conditions. In the case of the small portable machines the stone to be ground is fed into the mouth of the mill in pieces not much larger than 2½-in. cubes; it then passes into a circular chamber in which there are two or more massive, manganese steel hammers, flexibly attached to a rapidly rotating, central shaft. The stone is immediately broken and re-broken by percussion against both the swinging hammers and the walls of the chamber, some part of which, generally the lower half, is composed of stout, manganese steel bars arranged with narrow spaces between them, through which the stone dust can escape when fine enough. After leaving this screen the ground stone falls into a hopper whence it can be shovelled or bagged; it is, however, better to arrange the portable plant so that the stone is fed into the machine almost at ground level, and delivered direct into a cart. This can be readily done by providing a feed elevator to raise the broken stone to the mill, and a second elevator to lift the finished product and shoot it into a cart.

A plant as described above would cost at the present time about £600, mounted on wheels, complete with two elevators. The output would be about 1½ tons of ground stone per hour, and the power taken to drive the mill and its two elevators would not exceed about 15 B.H.P. It is obvious that on small estates where the initial cost of such a plant is more than the needs of one owner warrant, a co-operative scheme should be possible. Success will depend entirely upon careful selection of the plant and attention to certain details, some of which will now be described.

There are many makes of disintegrator on the market, but only a very few are really suitable for limestone grinding. It is important that the swinging hammers should be as massive as possible, and for this reason there cannot be many of them; two are enough, and any number above four is certainly too many. If the machine offered has four hammers, an opposite pair should be dismantled in order to determine whether the mill will not run easier and give the same output as before. Accessibility is an important feature, and the mill chosen must be of a pattern which can be easily opened up for examination of the grinding chamber and tackle provided to take the weight of any heavy parts not swung on a vertical axis.

The screen bars must be easily renewable, preferably in single units, not cast up together in segments; and should be made of manganese steel like the swinging hammers, as no other material is tough and durable enough.

It is a mistake to suppose that the spacing of the screen bars is a measure of the average or largest particles which will come through; the pieces of stone in the disintegration chamber are being driven round with a very high circumferential speed, and only when they are very much smaller than the width of the slots between the bars do they find their way through the screen. For this reason it will seldom be necessary to space the bars nearer than $\frac{1}{4}$ in., and for grinding chalk $\frac{3}{8}$ to $\frac{1}{2}$ in. will be suitable. The harder and more friable limestones will require the closest spacing of screens in order to give a satisfactory proportion of very fine dust.

When the mill has become much worn, care should be taken when renewing old screen bars that no ridge exists between the old and the new ones, since any unevenness in the periphery of the grinding chamber will cause a totally disproportionate quantity of large particles to go through.

The best results are obtained when the mill is run right up to the safe working maximum speed as stated by the manufacturers: loss of speed means not only smaller output, but a less finely ground product.

All varieties of limestone, if freshly quarried, *i.e.*, not much exposed to the weather after being broken, will be dry enough to grind without any preparation. This is, however, far from being the case with chalk. Soft chalk will need to be dried before it is passed through the mill, or it will "pug" and form a paste which will effectively block up the screen and stop the machine.

It is not easy to devise means for artificially drying chalk. Undoubtedly the best course to adopt, where covered storage space is available, is to quarry the chalk and leave it stacked under cover for several months to dry before it is ground. Where there is no such storage space, a drying floor is probably the simplest means, but experience shows that it will take nearly 1 cwt. of coal to dry a ton of chalk sufficiently to enable it to be ground. Some of the harder chalks will give much less trouble than soft chalk, such as that of the North or South Downs.

In any given instance it is easy to ascertain whether the raw material will require to be dried, for if on taking a fair sample and drying it out completely it is found to lose more than 12 to 14 per cent. of its weight, it will not satisfactorily go through one of these small portable mills without being dried beforehand.

THE CONDITION OF PERMANENT MEADOWS.

Professor R. G. Stapledon, M.A.,
University College of Wales, Aberystwyth.

Introduction.—In 1920 there were over fourteen million acres in England and Wales under permanent grass, and as much as 30 per cent. of this area was cut for hay.* It is not possible to form a reliable estimate of the proportion of the hay land which is set aside as permanent meadow, but there can be little doubt that most of the hay annually taken from permanent grass is harvested off the same fields year after year. The total area cut for hay from both permanent and temporary grass was over six million acres in 1920, and approximately 73 per cent. of this area was permanent grass. The above figures indicate that on the score of acreage alone meadows are an important feature of our permanent grass lands, but when considering the improvement of grass land attention is usually given chiefly to the betterment of pastures. During the War the writer—when inspecting grassland in a number of counties in England and Wales—formed the opinion that on the average the meadow land was more neglected and relatively less productive in relation to its potential capacity than the pastures. During 1920 opportunities presented themselves for examining the relative condition of pastures and meadows in greater detail in certain Welsh and south-western English counties. The results of this further survey confirm the view that the productivity of our meadows is very far from satisfactory.

The Weedy Condition of Meadows.—It is not only in the matter of yield that there is room for much improvement: perhaps the worst defect of meadow hay is its excessive weediness. If the weed contribution to the Nation's meadow hay could be expressed in tons alongside of the gross produce, it would be an instructive but not a pleasing figure to contemplate. Weeds are unfortunately not only a feature of very poor meadows but are often almost equally abundant on meadows which are regarded as excellent. The number of weed species which contribute in really large amount

* Agricultural Statistics, 1920, Vol. LV (1).

individually (5 to 10 and in some cases over 30 per cent.) to hay crops is comparatively small; the following are probably the worst offenders in this respect:—Sorrel (*Rumex Acetosa*), Yellow Rattle (*Rhinanthus* spp.), Beaked Parsley (*Anthriscus sylvestris*), Hogweed (*Heracleum Sphondylium*), Meadow Sweet (*Spiræa Ulmaria*), Hard Heads (*Centaurea nigra*), Ox Eye Daisy (*Chrysanthemum Leucanthemum*), Dandelion* (*Taraxacum officinale*) and Rib Grass (*Plantago lanceolata*).

Botanical analyses made on meadows in Lancashire which were apparently excellent (in a county which gives the highest average yields per acre from permanent grass†) have shown that the hay consisted in many cases of over 15 per cent. and in some cases up to nearly 30 per cent. of Sorrel. In the same county meadows came under observation where Dandelions were almost the predominant element in the flora. Meadows where this weed, with Rib Grass and Cat's Ear, contribute in abundance to the hay are not uncommon in Montgomeryshire.

Reports on manurial trials afford further evidence as to the weediness of meadow hay. At Garforth, on a meadow yielding above the average (for the country as a whole), the unmanured plot consisted of about 18 per cent. of weeds, chiefly Sorrel.‡ In Gloucestershire, on meadows yielding above the average, the unmanured plots have contained from 2 to 13 per cent. of weeds.§ Comparatively good meadows have been noted in Lancashire and the western counties, containing over 8 per cent. of Beaked Parsley. Yellow Rattle, although most abundant on poor meadows, sometimes contributes over 15 per cent. to the hay on comparatively good fields, whilst the hay from poor meadows in Wales has been analysed and has frequently shown Yellow Rattle to constitute over 30 per cent. of the hay produced.‖ The Ox Eye Daisy is abundantly met with both on fairly good and on very poor meadows. At Rothamsted, where the average produce from the unmanured plots is above that of the average of the country as a whole, the weed contribution to the hay on the unmanured plot is about 26 per cent.¶ At Cockle Park, where the average produce from the unmanured plots is below that of the average of the

* Soft Crepis (*Crepis virens*) and Cat's Ear (*Hypochoeris radicata*) are often fairly abundant, the former also being common on leys.

† 34·5 cwt. per acre for 1910–1919, and
36·4 „ „ „ 1903–1912.

‡ The University of Leeds, Agric. Dept., Bulletin No. 113.

§ Royal Agricultural College, *Sci. Bull.* Nos. 4 and 5 for 1912 and 1913.

‖ The produce of one meadow consisted of 45 per cent. of Yellow Rattle.

¶ A. D. Hall: An account of the Rothamsted Experiments, 1905.

country as a whole, the weed contribution to the hay on the unmanured plots is about 8 per cent.*

The above brief review has taken no account of Yorkshire Fog and Soft Brome—grasses which should certainly be regarded as weeds on most classes of meadow land. Both are grasses which ripen their seed early; when the hay is cut they are usually over ripe and will have shed most of their seed, and will, therefore, not contribute their full quota to the hay crop, but they will, by their vigorous growth, have hampered the development of other and later maturing grasses. Apart altogether from any question of their nutritive value, therefore, they can hardly be regarded as satisfactory meadow grasses. Both species frequently make an individual contribution of up to and over 50 per cent. to the hay of poor meadows, and contribute largely to that from first rate fields.†

The average weediness of meadows is chiefly due to the following causes:—

1. The complete withholding of manures.
2. Excessive manuring with farmyard manure.
3. Late cutting of hay.
4. Using fields as meadows for excessive periods.

The effect of farmyard manure in comparison with dressings of complete artificials, including sulphate of ammonia, is shown by reference to Table I.

It is apparent that farmyard manure alone and continually applied tends to make for a weedy hay, and that ammonium sulphate included in a complete artificial dressing tends largely to decrease weeds, even in the year of application (see Tarlton, Cricklade and Dry Leaze in the table). Farmyard manure is, however, in many districts practically the only manure applied to permanent meadows, and this largely accounts for the very weedy state of the great proportion of the meadow land in this country. This is well seen in Lancashire, where dung is liberally applied to the meadows which, as before shown, tend to be overrun with Sorrel and Dandelion and also contain an excess of Yorkshire Fog. Improvement in condition would follow if complete artificials were frequently used instead of dung. In many districts good results have followed the alternate use of dung and basic slag.

* County of Northumberland Agricultural Experimental Station, Cockle Park, Bulletin No. 18.

† Meadows in Wales have been analysed, showing Yorkshire Fog contributing 78 per cent. to the hay yield. Soft Brome has contributed 13 per cent. at Garforth (*loc. cit.*). Both are often abundant in the hay from water meadows.

TABLE I.—*Showing the gain (+) or loss (−) in weediness, in comparison with the unmanured plot, of plots manured with dung and with complete artificials, including ammonium sulphate.*

Centre.	*Dung.*	*Complete Artificials with Ammonium Sulphate.*
1. Rothamsted, 1856–1902	—	— 15·1
2. Cirencester,† 1888–1912	+2·4	— 2·2
3. Cockle Park,‡ 1897–1911	(1) −2·0 (2) +13·0	(1) — 6·8 (2) — 3·0
4. Garforth,§ 1899–1919	+18·6	— 6·0‖
5. Tarlton, 1913	—	— 10·0
6. Cricklade, 1913	—	— 7·0
7. Dry Leaze, 1913	—	— 2·4

1. A. D. Hall, *loc. cit.* 2, 5, 6 and 7 Royal Agricultural College, Sci. Bull. Nos. 4 and 5, 1912–13. 3. County of Northumberland Bull. No. 18. 4. Leeds Bull. No. 113.

† Analysis 1912.

‡ Analysis (1) 1905-1906 ; (2) 1907-1908.

§ Analysis 1909.

‖ Sulphate of Ammonia only.

The habitual late cutting of permanent meadows of necessity makes for weediness. The life cycle of coarse-growing plants is not then interfered with. The longer a field is left uncut and ungrazed the more are the perennial non-gramineous elements of the flora favoured, as also are annual weeds like Yellow Rattle, and, indeed, grasses like Yorkshire Fog and Soft Brome which so largely perpetuate themselves by excessive seeding. The rapidity with which meadows deteriorate under the prolonged influence of late cutting is not fully appreciated, the farmer being content to sacrifice the quality of his hay and the condition of his fields for a somewhat problematical increase in bulk.*

Weeds of meadows are in many cases decreased by heavy grazing, and there can be no doubt that much meadow land would, in the last resort, be more productive of human food if used for a number of years as pasture. The conversion of meadows yielding heavy crops of weedy hay into pastures would of course necessitate the production of hay by other means. This aspect of "meadow" improvement is dealt

* In any particular year the greatest bulk is likely to be harvested from late cut hay, but when the effect of progressive deterioration is taken into account it is probable that over a series of years a greater gross produce per decade would be obtained from earlier cutting, and this would certainly be so on poor land. In the writer's opinion the deterioration aspect of late cutting is of greater significance than the loss of nutritive value in any particular season.

with in a subsequent section. Yellow Rattle,* Hard Heads and Sorrel are all weeds that can be decreased, and the two former practically eliminated, by early and prolonged heavy grazing, especially with sheep; under meadow conditions this is not practicable, since the fields have to be put up to hay before the full benefits can be obtained. Yorkshire Fog and Soft Brome are much less abundant under pasture than meadow conditions.

The Average Poor Yield of Meadows.—During the period 1903-1912 the average yield per acre from meadow hay for England and Wales was 23.59 cwt.; for the period 1910-1919 the average yield was 21.70 cwt. The unsatisfactory nature of these figures is clearly shown in Table II, in which the yields obtained from the unmanured plots are compared with those recorded from adequately manured plots at 20 centres.

TABLE II.

Centre.	Hay in Cwt. per acre.	
	Unmanured.	*Manured.*
Rothamsted[1]	23·20	54·10[8]
Cirencester[1]	19·75	35·50[8]
Cockle Park[1]	19·00	30·25[8]
Garforth[1]	24·00	32·25[8]
„	„	47·00[2]
Saxmundham[3]	9·50	29·00[8]
8 centres in England and Wales[4]	29·30	38·70[8]
4 „ „ Gloucestershire[1]	18·80	30·60[8]
Harper Adams[5]	19·50	32·25[8]
„ „	„	30·75[8]
Seale-Hayne[6]	10·00	18·50[8]
„ „	„	16·00[4]
Herefordshire[7]	27·00	37·50[8]
„	„	31·00[4]
Average for the 20 centres	23·00	34·00

[1] *Loc. cit.*
[2] Farmyard Manure only.
[3] East Suffolk County Education Committee, Report, March, 1914.
[4] Dyer, Dr. Bernard and Shrivell, F. W. F., Results of Grass Manuring Experiments, 1910.
[5] Harper Adams Agricultural College, Guide to Experiments, 1914.
[6] Seale-Hayne Agricultural College, Report No. 2, 1913.
[7] Herefordshire County Council, Farmers Bulletin, No. 5, 1920.
[8] Complete Artificials with Nitrogen.

The results indicate that the average produce for the country as a whole comes very close to the average of the unmanured

* Yellow Rattle, as Gilchrist has shown, can be greatly decreased by early cutting, while it can be almost completely eradicated by a number of years' heavy grazing. Experiments at Bangor and at Aberystwyth have shown that dressings of finely powdered agricultural salt applied early in the spring, when the seedlings are just coming up, are able to kill it.

plots at the centres under review, thus suggesting that a large proportion of our meadow lands are left unmanured from year to year. It will also be noted that the increases due to full dressings of artificials or of dung are very substantial. If individual centres are examined it will be found that even fields giving yields well above the average of the country are capable of considerable increases under adequate manuring. Thus Irish experiments show increases of 20 cwt. per acre on fields giving 40 and 42 cwt. from the unmanured plots.* Dyer and Shrivell's figures show an increase of 6 cwt. from 37 cwt.; a field yielding 69 cwt. (unmanured), however, showed slight decreases under all systems of manuring.†

It is not the purpose of this article to discuss the best manurial dressings for meadow hay, but rather to emphasize the need of radically improving our meadow lands, and to indicate some of the methods which are applicable with a view to this end. Nothing is of greater importance than an increased use of manures.‡

Meadow versus Seeds Hay.—It has been suggested that much of our meadow land would benefit by being used as pasture for at least a number of years, but in order to do this it would be necessary to produce more hay by other means. It has been pointed out that seeds hay is only taken from about 28 per cent. of the total area cut for hay, yet seeds hay on the average of the country as a whole yields 6 cwt. per acre more than meadow hay. The relative yields from meadow hay and seeds hay for typical areas are set out in Table III.

It will be noted that in the main those areas where the leys are not typically left down for long show the greatest increase in favour of seeds hay. This is of course to be expected, since the first year's cut of seeds is usually the heaviest. In Central Wales, Derbyshire and Westmorland, where the leys are left down for several years, the seeds hay yields are 5 cwt. better than the meadow hay, despite the fact that the seeds mixtures employed are usually inadequate.

It is interesting to note that Lancashire gives the heaviest

* Department of Agriculture and Technical Instruction for Ireland, Leaflet No. 37.

† Dyer and Shrivell, *loc. cit.* The soil was a somewhat heavy loam and the field was an old pasture.

‡ For particulars as to the best means of manuring meadow hay the reader should refer to the publications already cited, to one of the Ministry's Miscellaneous Publications, No. 24, *The Improvement of Grassland*, and to an article on the Increased Production of Grass by Gervaise Turnbull, Vol. XXVI (p. 607) of this *Journal*.

Table III.—*The average yields from meadow hay and seeds hay compared. The figures are based on the average of the statistics for the periods* 1903-1912 *and* 1910-1919.*

Areas.	*Increase, in cwt. per acre, of Seeds Hay over Meadow Hay.*
England and Wales	6·0
Cambridge, Essex and Norfolk	7·2
Lancashire	8·9
Cardiganshire, Radnor and Brecon	5·2
Derby and Westmorland	5·1

average yields of meadow and seeds hay, and that Westmorland also takes a high place in respect of both, although the leys are frequently left down for two, three or more years.†

In respect of yield, therefore, average figures are markedly in favour of seeds hay. There are unfortunately not many exact experimental data available contrasting the yields from well managed leys and from permanent meadows on similar soils. The following trials, however, afford further evidence.

Seale-Hayne Agricultural College (*loc. cit.*).—Mixtures for 3 or more years were put down in 1910; the average yield‡ of hay per acre per annum for the first two years was over 36 cwt. for the five plots sown, the highest per annum average being 41.75 cwt. The yield in the first year was nearly 12 cwt. greater than in the second. Another series of plots gave from 42 to 47 cwt. of hay in the first year.

Manurial experiments on permanent grass did not give a higher yield than 25 cwt. The soil was apparently, however, decidedly poorer on this latter field, so that the comparison is unfortunately not a fair one.

Cockle Park.—Gilchrist§ has conducted exhaustive trials on seeds mixtures at Cockle Park; well balanced mixtures, including Cocksfoot (6 to 12 lb.) and Wild White Clover, have been employed on poor and stiff clay soils. The best mixture under the best manurial treatment has averaged a yield of

* Agricultural Statistics, Vols. XLVIII (Part II) and LV (Part II).

† It is somewhat remarkable that Leicestershire and Northamptonshire, famous for their pastures, take a low position in respect of both meadow and seeds hay; the best fields, however, are not brought under the plough, and probably only the poorer grass fields are put up to hay.

‡ The second year yield from the Elliot Mixture (with 8 lb. Cocksfoot) came within 8 cwt. of the average of all the first year yields.

§ Gilchrist, Prof. Douglas A., Northumberland County Agricultural Experiment Station, Cockle Park, Bulletin No. 31, 1920.

33 cwt. per acre per annum for 12 years. Averages of 46 cwt. per acre per annum have been obtained, for three-year periods.

Permanent meadow land under dung and artificials has averaged 41 cwt. per annum for 23 years; under artificials alone 30 cwt.

Saxmundham.—Mixtures have been down for 8 years. The best mixture under the best manurial treatment has given an average yield of 29 cwt. per acre per annum over the period, which is precisely the same yield as that averaged on permanent meadow under the most productive manurial treatment for a period of 12 years.*

West Aberdeenshire.—Five plots sown in 1911 gave an average yield of 43 to 49 cwt. per acre per annum for a three-year period. The yields in the first year ranged from 66 to 75 cwt., in the second from 33 to 37 cwt., and in the third from 29 to 40 cwt.†

Central Wales.—Hay yields in the first year varying from 40 to 60 cwt. per acre have been obtained. An extensive series of trials was started in 1912, but owing to the War it was impossible to obtain results after the first year.

The above figures show that under proper manurial treatment heavy crops may be obtained from seeds hay for a number of years. The first crop is usually the heaviest and may be more bulky than that obtained from even the best meadows highly manured. High average results may be harvested for three or four years—results as good, and in some cases slightly better than those obtained from well manured permanent meadows on similar soils. The Saxmundham trials have shown that mixtures of the Elliot type are less dependent on manuring than are more ordinary mixtures or than permanent meadows.

The foregoing review has only taken account of bulk. It is, however, on the score of freedom from weeds, including Yorkshire Fog, Bent and Soft Brome, that well managed seeds hay is so much superior to even well manured meadow hay. The worst weeds of meadow hay do not make an early appearance on leys, whilst by resort to a well balanced mixture of highly pure seeds (including a sufficiency of Cocksfoot), Soft Brome and Yorkshire Fog can be successfully suppressed for at least three to six years. The inclusion of wild white clover makes for a clean sward which, under good manage-

* *Loc. cit.*

† North of Scotland Coll. of Agric., Experiments, Leaflet No. 46.

ment, may be maintained in a high state of productivity for at least a decade.

Botanical analyses of the seeds hay are not available for the centres referred to; the writer, however, made rough estimates on the plots at Seale-Hayne and at Saxmundham in 1917.*

At Seale-Hayne, Elliot mixtures then 5 and 7 years down were remarkably free from weeds. At Saxmundham the degree of weediness of the plots expressed on a scale of marks was as follows:—

Permanent meadow, unmanured	180
,, ,, slagged	120
Elliot Mixture	25
All other mixtures (average)	90

Numerous analyses on leys of various ages have been made in Central Wales. When good seeds mixtures have been used the swards have been free from weeds for several years, but Yorkshire Fog generally begins to be abundant after the fifth year. This grass always tends to become abundant on fields continually cut; thus at Saxmundham it was almost equally abundant on the permanent meadow plots and on the ley plots eight years down, whilst on the Cockle Park meadow hay plots this grass has increased on even the "artificial" plots, and particularly on the dunged plots during 9 years.†

Having regard both to freedom from weeds and from Yorkshire Fog and also to the production of maximum bulk, it appears therefore that the four- to five-year ley has much to recommend it as a means of increasing the hay supplies of a farm. Meadow hay has of course a special value, since it is a safe feed, but the hay of a good ley in its third to fifth year, when the Red and Alsike Clovers will have more or less completely disappeared, is not very different from meadow hay, except that it is likely to be far less weedy!

There are many farms in Wales and the West of England where good fields—fields with a high potential grazing value—have been ruined by continual mowing: these fields should be heavily slagged and heavily grazed. An extension of the temporary ley on the more ploughable part of the farms would at once have the effect of (1) providing the necessary amount of hay, and (2) what from the Nation's point of view is so much to be desired, namely, keeping land under cultivation.

* The estimates were made in connection with an inquiry conducted for the Food Production Department. Thanks are due to Mr. B. N. Wale and to Mr. A. W. Oldershaw for information and assistance.

† Northumberland County Agricultural Experiment Station, Bulletin No. 8.

SIMPLE COST ACCOUNTS FOR FARMERS.

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AT the present time farmers may find it advisable to pay Income Tax upon profits under Schedule D rather than under Schedule B, in which case it is necessary that they should adopt some system of account keeping. It is possible indeed that Schedule B may be withdrawn. The most desirable system of book-keeping is one based upon "costs." Not only does it obviate the danger of the farmer being called upon to pay tax upon profits he has not realised, but it can be made of great help in the conduct of his business because it makes clear what the various parts of the business are contributing to the final result. It is often objected that farming must be looked at as a whole, that the flock and the bullock feeding are so bound up with the corn growing that one can neither say how much one makes in comparison with the other, nor change the way of farming to correspond with the estimated profits or losses. No great difficulty will, however, be found in separating the costs of the main items of the business of a particular farm, like the corn growing, the milch cows, the flock, &c., and the farmer who is persistently confronted by a loss in one department will not be long before he finds a more profitable way of conducting that part of his business and exchanging it for some other. The great point of cost accounting is the power of control which the farmer obtains by thus seeing how the various items which go to make up the business of a farm are each of them answering.

Again, a cost account gives a much sounder statement of the results of the year's working. Under the ordinary system of book-keeping a valuation has to be made at the beginning and end of the year, and these valuations are combined with receipts and expenditure to make up the profit and loss account. The valuations introduce two sources of error. The quantities of produce like corn may be incorrectly estimated and the values attached may never be realised. Again, the valuation confuses stocks which are only used as "plant" and are not meant for sale with the produce of that plant. For example, between Michaelmas, 1919, and Michaelmas, 1920, the valuation of the ewes in a breeding flock had appreciated by something like £3 a head. Unless the farmer is meaning then and there to dispose

of his flock that appreciation is not realisable and should not be treated as a profit, as it would be under the ordinary system. On the valuation plan the farmer shows profits (or losses) that have not been realised and may have to pay tax upon them; on the costs basis as little as possible beyond cash realised comes into the final account—there is no anticipation of profit. Of course there is equally a valuation at the beginning and close of the year, but it is really in the nature of a stock taking, in which the stock is valued at its cost.

The chief objection of the adoption of a system of cost accounts is the amount of book-keeping involved, requiring more time than can be given to it by the ordinary farmer, who rightly enough considers that he will get most value for his effort if it is spent out of doors seeing that the work is kept up to the mark. A farm of under 500 acres will hardly pay for a book-keeper unless it is intensively cultivated. But on the smaller farms the labour of cost accounting can be greatly reduced and brought within the compass of a master who can only give a few hours a week to it, even if he can get no assistance. What is necessary is to abandon the effort to obtain the cost of production of individual crops and to adopt a few arbitrary rules for the valuation of young live stock. If one is to obtain separately the costs of growing wheat and of growing oats it is necessary to open an account for each field and to allocate week by week the labour, manual and horse, spent on each field. This means not only a good deal of labour in making up the time sheets day by day but a lot of actual desk work in transferring the particulars to the books.

In the end little is gained by ascertaining how much more profitable Field A is as compared with Field B, or that wheat, for example, pays better than oats. Both have to be grown for reasons dictated by the rotation, and in so far as the farmer can shift a little from one to the other ordinary considerations of yield and price give him sufficient guidance. The more important question is what the arable land as a whole is yielding as compared with grass, and whether the crops or the stock are bringing in the money. Of course a special account can always be opened for some particular crop about which the farmer wants information; for example, he may be a considerable potato grower or may wish to know whether that crop is worth developing, in which case he must go to the extra trouble of finding the cost of the labour, manures, &c., spent on the potato acreage as distinct from the rest of the arable land.

While the complete system of costing is very desirable the

purposes of the majority of farmers will be met if the farm is divided into a few main departments, for each of which the books will provide a closing account and a profit and loss statement. These closing accounts would vary with the farming but would be in the majority of cases selected from the following: Arable land crops, with, in some cases, Potatoes as a sub-head; Old land for hay; Milch cows; Bullock fattening; Breeding or Flying flock; and Pigs.

Cost book-keeping begins essentially with an allocation of horses and manual labour to the separate departments for which a closing or working account is kept. This can be considerably simplified by marking off some of the men once and for all; for example, the horse-keepers or carters can be charged straightway to the horse working account, the shepherd to the flock account. One man may be attending to both cows and pigs; his annual kept and the times entered up weekly to the various accounts. But for the labourers and for the horses a time sheet must be kept and the times entered up weekly to the various accounts. One need not attempt to work on a smaller unit than a half-day. This then is the chief trouble, the maintenance of a weekly time sheet allocating labourers and horses to crops, hay land, grazing land, flock, cows and pigs, and to some general account for odd jobs like repairs, fences, &c., which cannot well be assigned to any particular working account.

The Initial Valuation.—The first step to take consists in fixing the date at which the working year begins, Michaelmas or Lady Day, and making the initial valuation, which cannot be on a strictly cost basis.

As regards the *dead stock* the best plan is to enter every article up in a Stock Book and set against it its present value, the amount of depreciation to be taken off each year, and a final value below which it will not be written down as long as it remains in commission. The amount to be written off each year will be an arbitrary figure determined by the probable life of the article. For example, it will be wise to write 25 or 30 per cent. off the value of a tractor every year, while 7½ per cent. would be enough to write off a plough. A fresh column is taken for each year and in it is entered the depreciated value of each article or a blank if it has been broken or sold, so that the total of the column gives the amount to be entered in the valuation, while the difference between the total and the total of the previous year gives the amount that is to be charged out as depreciation. The implements may be grouped according to the different closing

accounts which are to be debited with the depreciation on their group, or the total depreciation may be divided in proportion to the respective labour bills.

Horses may be treated in the same way; a value is attached to each with an annual depreciation of £6 or £7 a head to be charged to the horse working account. In the case of young horses the depreciation may be exchanged for an appreciation up to the age of seven but little is to be gained by so doing, since the horses are not intended to be sold.

For the *milking herd* a standard value should be adopted for all the cows in milk; this value is to be retained in all subsequent valuations and multiplied merely by the number in order to obtain the valuation. If the farmer rears his own heifers, heifers and calves of all ages up to the time they begin to milk are valued at half the standard value of the cows.

For *store stock* other than heifers an initial valuation of 10 per cent. or so below the estimated market price may be made.

For the *breeding flock* a similar method is to be adopted. A standard value is taken for a ewe, another for any rams, and their values are kept unchanged from year to year, so that the total valuation only varies with the numbers. A similar standard value is placed on all lambs and tegs; this may be half the ewe value in a Michaelmas valuation for a flock lambing about Easter, and three-quarters of the ewe value for such lambs as remain unsold at Michaelmas from an early lambing flock. In the case of a Lady Day valuation only the ewes are reckoned.

In the case of a *flying flock*, the cost price, if a recent purchase, or a market valuation less 10 per cent., may be adopted for the initial valuation.

For the *pigs* the same principle may be adopted. The breeding sows and the boar have standard valuations attached to them, not varying from year to year, and a market valuation less 10 per cent. is put on the store pigs.

The *tillages* are valued at their estimated cost. It is simplest to ignore unexhausted residues of foods or manures, as they only become a realisable asset when the occupier leaves the farm and the variation from year to year will not be great. For the purposes of the balance sheet a fixed value may be adopted and carried forward from year to year.

Similarly the *farmyard manure* may be valued at a fixed price.

The *crops* must be valued, not only the corn, but the roots and the green crops. For the feeding crops it is necessary to adopt a series of arbitrary standard values, which properly

should be the cost of growing less allowances for the cleaning and manure by which succeeding crops benefit. As these cannot easily be worked out by the farmer, the following arbitrary figures may be adopted :—

Mangolds, Swedes and Turnips, to be carted off, £15 per acre.
Swedes and Turnips to be fed off, £10 per acre.
Vetches, Kale, Rape, &c., to be fed off, £8 per acre.
Feeding Stuffs, Manures and other stores in stock may be taken in at cost.

Working Accounts.—Having prepared a valuation, a series of working accounts must be kept in ledger fashion, and it is necessary to determine how many of these accounts shall be opened. The following will prove to be sufficient for most farms :—

Manual labour.	Farmyard manure.
Horse labour.	Milch cows.
Grazing.	Store cattle.
Meadow hay.	Breeding flock.
Crops (3 accounts).	Flying flock.
Feeding stuffs.	Pigs.
Artificial manures.	Establishment, and
Implements.	Cash.

Taking these accounts one by one they will be treated as follows :—

(1) *Manual Labour.*—All the wages go into this account as debits. As credits the wages of the horse keepers are transferred quarterly to the horse working account, of the shepherd to the flock account, of the stockman to cattle and pigs, as previously explained. As regards the labourers, on the credit side a record is transferred week by week from the time sheets of the days spent on the various departments of the farm, and quarterly the cost of the labourers is divided in proportion to the days and assigned to the respective accounts.

(2) *Horse Labour.*—This account is debited with the depreciation on the horse stock, with the labour of the horse keepers, with the oats and other feeding stuffs, and with an item for grazing. On the credit side are recorded the number of days worked for the different departments. The total cost of the horses is divided by the number of days so as to obtain the cost per day, and the various departments are debited with this cost per day multiplied by the number of days work they have had, so that the account is cleared like the manual labour account. The cost of the horse day is an important figure for comparison from year to year. It should also be calculated

after excluding the wages of the horse keepers so as to show the cost per diem of the horse alone.

(3) *Grazing Account.*—This should be charged with the rent of the permanent pasture land and with one-third of the rent of the meadows laid up for hay and only grazed as aftermath. It is also charged with labour, manure applied to pasture, any cake or corn fed on the pastures, and with a proportion of the depreciation of implements and establishment expenses. On the credit side a record is kept of the number of days grazing, reckoning a cow or bull equal to five sheep, heifers and young cattle equal to three sheep, horses turned out for the night equal to two sheep, horses wholly out to grass equal to five sheep. The total number of sheep days grazing thus obtained is at the end of the year divided into the gross expenditure so as to obtain the cost of one day's grazing, and the account is then cleared by charging each of the livestock departments with the number of days' grazing it has had.

(4) *Meadow Hay.*—This account is charged with the rent of the fields laid up for hay, with the manure applied and the labour spent on the fields and during hay making, also with a share of the depreciation and establishment expenses. On the credit side one-third of the rent and of the manure is debited to grazing as representing the after-math. The quantity of hay produced is estimated and charged to the feeding stuffs account at 10 per cent. less than market price. The balance of this account goes to profit and loss.

(5) *Crops.*—As most of the crops are unrealised at Michaelmas it is necessary to open separate accounts (a) for the unrealised crops, (b) for the crops that are being grown during the year, and (c) for any tillages that may be made before Michaelmas for the succeeding year's crops.

The first account will be debited in the first instance with the valuation of the crops at Michaelmas, or in succeeding years with their costs. It will be further debited with any additional work spent on these crops, as, for example, thrashing and delivery. The credits will be the corn sold and the roots and other green crops at standard values as indicated above, these being debited to the appropriate livestock departments. The balance goes to profit and loss.

The second account for the year is debited with the tillages in the valuation, with manures, seed, horse and manual labour, and a share of establishment expenses and of depreciation on the implements. On the credit side comes the seeds

hay sold to feeding stuffs at market price less 10 per cent., the green crops consumed during the year at the standard values, and the grazing of the seeds, to which a similar standard value must be attached. The balance at Michaelmas is transferred to the valuation, and becomes the debit with which the (a) account starts in the following year.

The third account, which is only opened towards the close of the year, contains horse and manual labour, manure, &c., for the crops of the succeeding year, and is also transferred to the valuation, whence in the following year it is transferred to the (b) account.

(6) *Feeding Stuffs Account.*—This is only made up for convenience. It is debited with the stocks and the feeding stuffs bought and the hay from both the seeds and the meadows. It is credited with the amounts transferred to the various live-stock departments and any stocks in hand at Michaelmas.

If considerable quantities of artificial manures are bought it is convenient to have a similar account for them. Again, an account must be opened for the depreciation of the implements as ascertained from the Stock Book, to which must also be added expenditure on repairs, to be balanced by credits from the accounts among which the whole costs are to be divided.

(7) *Farmyard Manure.*—This is debited with the straw and the manurial value of the foods fed to the cattle or pigs in yards, also with the labour spent on clearing the yard and making mixens. An estimate may be made of the quantity of manure when carted out on to the land so as to obtain a figure of the cost of a load of farmyard manure for comparison from year to year. When aiming at simplification this account may be dispensed with altogether, in which case no credit is given to the crops for the straw that is used upon the farm or for the manure value of the foods, while the labour spent on the manure is charged straight away to the crop account.

(8) *Milch Cows.*—The debit starts with the valuation: cows and bulls at their standard values, the heifer calves at their standard values. Any additions to the herd that are purchased are debited at cost but depreciated year by year at a certain rate to bring them down to the standard value. Further debits are the feeding stuffs consumed, grazing, horse and manual labour, and a share of the depreciation and establishment expenses. The credits are the sales of milk, of calves, of cast cows. If an account is opened for farmyard manure the manure values of the foods consumed are credited to this

account and debited to farmyard manure. The balance goes to profit and loss.

(9) *Store Stock.*—Any stores on the farm at the beginning of the year are debited at the valuation, other stores purchased at their cost price. The further debits are the feeding stuffs they consume, including crops, the horse and manual labour attributable to the stock, and the share of establishment expenses. The credits are the sales, and the manure value of the foods if a farmyard manure account is opened. If at the end of the year there are still some stock unsold the total of the debits should be divided by the number of stock either sold or still on hand, and those remaining on hand valued forward to the next year at the average cost per head. There will be a balance on this account to be carried to profit and loss.

(10) *Breeding Flock.*—The debit begins with the valuation, the ewes and rams at their standard price per head, and the lambs at their standard price. The other debits will be ewes purchased and rams hired or purchased, the crops and feeding stuffs consumed by the flock, the horse and manual labour, and the depreciation and establishment expenses. The credits are the sales of the lambs and tegs, cast ewes and wool, together with the closing valuation made by numbers at the standard values. The manure value of the foods consumed should be also credited to this account and charged to crops.

(11) *Flying Flock.*—This is treated exactly like the store stock account. The debits are the initial valuation or the purchase price, the crops and feeding stuffs consumed, the labour and the establishment charges. The credits are the sales and the valuation of whatever may remain unsold at cost, the cost being divided as before according to the numbers sold or unsold.

(12) *Pigs.*—The debits begin with the valuation of the stock sows and boars at standard values, together with the store pigs at their standard values. Other debits are the feeding stuffs, labour and establishment charges. On the credit side come the sales and the valuation of the store pigs unsold. This valuation is again made by their numbers multiplied by the ascertained average value of keeping a store pig for the part of the year it is on the farm, *i.e.*, the total costs divided by the number sold during the year and on hand at the closing date.

(13) *Establishment.*—This account is debited with the labour spent upon such operations as cleaning ditches, fences, road mending and other repairs, together with sundry items like travelling expenses, stationery and postages, which cannot

be specifically allocated. At the end of the year the total should be divided up among the various closing accounts on some conventional basis, such as the relative expenditure on labour in each department or in proportion to the turnover.

(14) One more account is necessary into which are brought the bills owing or unpaid, the cash in hand and at the bank, and the capital.

It is difficult to make clear in the brief space available a system of book-keeping, and many readers may be led to feel that the method proposed is far too complicated for them to take up. Actually, as soon as the principle has been grasped and the farmer has got over the first difficulty of starting, the system will be found to work with surprising ease. Mr. C. S. Orwin, the Director of the Institute for Research in Agricultural Economics at Oxford, will be glad to assist any farmer who wishes to start book-keeping on these lines.

THE CONTROL OF FARM MANAGEMENT AND SOME FUNDAMENTAL PRINCIPLES IN AGRICULTURAL COSTING.

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The importance of the study of Farm Management is receiving recognition only slowly. The expansion in agricultural education and research work which began about five and twenty years ago has been confined almost entirely to natural science, and although results of enormous practical value to the farmer have been produced, the full benefit of such work has not been secured owing to the neglect of any attempt to balance it by the study of agricultural economics. The economic law with which production from the land has to contend is the law of diminishing returns, while any attempt to wring the last bushel of corn from the land and to produce the last pound of meat and the last gallon of milk can only be justified so long as it can be shown that maximum production is accompanied by maximum financial reward. It is always the economic factor that, in the long run, controls production. Soil and climate are factors of obvious importance, but innumerable examples can be given of the adaptation of poor soils to most intensive husbandry, given suitable conditions as to supplies of fertilisers and accessibility of markets, whilst far better soils under less favourable economic conditions are perforce devoted to far less productive systems of management. The successful farmer is not necessarily the man who produces that which soil or climate or inclination indicate, but he who, after a study of economic factors, decides which will be most profitable. Such a study depends largely upon his ability to examine, by scientific book-keeping, the processes of production.

Costing, or management book-keeping, aims at much more than mere financial accounting. The latter is intended to furnish evidence as to the general financial position of a business at any time; the former supplies the only means by which the management of an enterprise can be tested and examined in all its departments. When industry was in a primitive condition—when people were producing mainly to satisfy their own individual needs—there was no necessity for an analysis of the costs of the various processes of production, but in proportion as the

producer worked to supply not only his own wants but also those of the open market, in which he had to compete with other producers, so the need for controlling production increased. Every enterprise working to supply a market has two sides—the technical side involving technical skill in the various processes, and the managerial side, which controls the technical skill so that effort may be applied economically and the final product-cost reduced as low as possible. As a business grows so does the tendency to separate the functions of the technical and the managerial staff increase, until in the great industrial organisations of to-day we find a fairly complete division between them. This has given opportunities for individuals who, knowing little or nothing of the technical side of a business, are yet able to control it successfully by a system of management based on records of cost in every process. "A man who is 100 per cent. efficient as the manager of one particular business will prove to be 90 per cent. efficient as the manager of any business" is the dictum of a certain successful manufacturer, who thus appears to value technical knowledge in a manager at no more than 10 per cent. of his total equipment, and it is certainly true that most large industrial enterprises of our day are controlled by men who are experts in management and in analysing the processes of production rather than in technique.

In agriculture, such specialisation has not gone so far, except in a few cases. Men of proved ability in industrial organisation not infrequently turn their attention to farming, but do so generally as a relaxation or for social considerations rather than as a business proposition. There are, however, conspicuous cases of men who, knowing nothing whatever of farming, have made a great success of it, and it may be surmised that the direction of any large agricultural venture would be better in the hands of the man who had proved himself competent to run a big productive organisation of any kind than in the hands of one who had merely shown good technical ability in running a small farm. Although large-scale production in agriculture is rare, and the manager and the technical expert usually "wear the same hat," this detracts in nowise from the importance of management and the means of directing it, and probably the greatest weakness in the agricultural industry to-day is the reliance of the farmer on his technical knowledge to the more or less complete exclusion of the study of management. The farmer must come to recognise that his skill as a practical man requires direction, and that he can never be sure that he is making the best use of the factors

of production without the means of examining and testing the application of his technical ability.

The basis for any system of management book-keeping for the farm is the *Valuation*, and more errors in costing spring from false principles in this matter than from any other cause. In industrial undertakings the position has been established firmly and clearly enough. With rare exceptions the principle is to value plant at cost, less depreciation; to value goods in the process of manufacture at cost; and to value manufactured stock at cost, or at cost or market-value, whichever be the lower. In agriculture the position is equally clear and definite, and it is the almost universal practice to value practically everything at market price. The explanation of this difference in practice is that in farming there is not the sharp line of demarcation between plant and product that exists in other forms of industry. A ewe may be regarded as a machine for the manufacture of meat and wool, but it is a machine which, in due course and before very long, itself goes to market as a commodity. Indeed, the amount of working capital invested in the farm in plant and equipment of a permanent or semi-permanent nature bears a very small proportion to the total capital, and the fact that the bulk of the "machinery" for production will itself be placed on the market, combined with the fact that costs of products in the process of manufacture are never available, has led to this difference of principle in making valuations on the farm as contrasted with the other forms of industry. It must be remembered, however, that although the ewe and the cow fulfil their purposes of manufacturing animal products for the market for a short time only, and are then themselves marketed, the flock and the herd remain, and it is these rather than their individual members which must be regarded as constituting the producing plant, and their valuation should remain at a figure constant from year to year, except in so far as this sum is affected by changes in the total numbers of the flock or herd for the year. Regarded in this way there is no longer the difference between the productive machines of the factory and those of the farm, and the valuation of the latter can and should be made on the same basis as that of the former. Thus, the valuation of flocks and herds is a matter of numbers only, the value per head, based on the cost or estimated cost of the animals, being kept at a constant figure from year to year. Depreciation, which is necessarily deducted in the case of dead stock used in the processes of production, does not enter into the annual valuation of live stock,

as the state of the flock or herd is maintained at a constant level by the sale of old animals and the introduction of young ones.

The valuation of stock on a market value basis robs the accounts of their whole use as a guide to management. The final product-cost will include a concealed profit or loss. For temporary causes, such as a shortage of keep at home or the closing of foreign ports to imported live stock, may turn a profitable year into one, apparently, of serious loss if market values are assigned annually to breeding stock not intended for immediate sale. Similarly, a temporary inflation of values for any cause would lead to unwarranted optimism as regards the year's results in the particular department concerned. Many men to-day are farming with the same stud of horses they had seven years ago. They have seen the average market value rise, in many cases by some 200 per cent., and fall again nearly to the original value. An annual valuation based on the market value of the day could have caused nothing but confusion, as introducing paper profits first and then paper losses, neither of which would have had any actuality.

In valuing crops the same cost principle must be adopted. There is no need to speculate as to the probable yield of a field of roots or a stack of corn and then apply some market price to the result which, in the former case, can have no possible reality, and in the latter case may be entirely falsified by the turn of events before the corn can be marketed. The cost of the crop up to the date of valuation compared with the market price subsequently realised enables the farmer to assess the results of his management in this department. If the crop be fed to stock on the farm instead of being marketed direct, the financial result is obtained when the stock is sold, and the farmer is in a position to contrast the results of direct and indirect marketing, together with such questions as crop substitution and so forth. If once the actual facts of the farmer's own experience as revealed in his books are allowed to give place to values assigned by others, all basis for comparison is lost.

Having settled the basis on which to make the valuation, other questions arise in agricultural costing for the treatment of which definite principles must be laid down if the results are to have any real value as a guide to management. One of these is how to deal with *Rent*. In the sense in which the term is used by economists, rent is not an element of cost, for it represents nothing more than the value of production due to variations in situation and the inherent capabilities of the soil. "Rent is due

to differences in the productivity of different pieces of land, the users of which are working for the same market, differences over which the owners have no control. From this the corollary is drawn that rent does not enter into the cost of production. Corn, in Ricardo's words, is not high because a rent is paid but a rent is paid because corn is high."* This theory of rent is interesting as an economic conception which, in certain special cases, may even have a practical application, but to the English farmer in most places it is merely an abstraction, and to give the term the peculiar limitations assigned to it by economists, and then to say that rent does not enter into cost of production, is to create a set of conditions having no existence in fact on most of the farms of this country. The rent paid by the farmer has little or nothing to do with the inherent capabilities of the soil, except in particular cases which do not bulk large in the agriculture of the country as a whole, for it represents nothing more than a certain return to the originator of the enterprise, or his successors, on the cost incurred in bringing virgin soil into the condition precedent to the production of food and other agricultural produce.

Rent is the interest which the capitalist expects to get as an inducement to him to invest money in draining, enclosing, road making, erection of houses and buildings, and in other works of reclamation and equipment necessary to turn virgin soil into farm lands. It is true that farms created at equal unit cost in the past may let to-day at different unit rentals, but this is not to say that those commanding higher annual values include in this value an element of rent as defined by economists; rather does it mean that those letting at the lower figures are giving to the capitalist a lesser reward for his enterprise.

It follows that rent paid by the farmer, except in particular and relatively unimportant cases, is an element in the cost of production and must be included in cost determinations. There seems to be no common agreement as to its distribution over the farm, but if it be accepted that rent represents some return on the cost of reclamation and equipment and nothing more, it is obvious that it should be divided over the farm upon an acreage basis.

The question of a charge for *Interest* also requires consideration. If it be accepted that the cost of an article can be nothing more than that which is paid for it, it is clear that interest on capital is not a charge against cost, and as a general rule

* Clay, H., *Economics*, p. 356.

accountants appear to be agreed about this. In estimates of agricultural costs appearing from time to time in the press, the practice of charging interest is one of the commonest errors, the argument being, apparently, that the farmer is entitled to charge, as part of his cost, such a sum as the capital involved could have earned had it been invested in some other security. Money in the form of capital invested in, say, War Loan cannot be used to produce milk or other farm produce; therefore there cannot be a charge against milk of the sum which the money would have earned if employed in War Loan. It is, of course, of vital importance to the farmer to consider, from time to time, what rate of interest he is getting on his farming capital, but he must not attempt to anticipate this calculation by including interest charges in his costs. The proper time to do it is when his balance-sheet for the year is before him. A milk producer may find that on a capital of £10,000 invested in his farm he has obtained a profit of £1,500. From high class securities he could have obtained an income of £600 by the investment of a similar amount; from good industrials, £800; from speculative investments, £1,000 or so; and in each of these cases he would be free to be employed in some salaried capacity. It is then for him to decide whether, having regard to other opportunities available for the investment of his capital and the alternative employment of his own time, he would be better advised to give up farming. Interest on the farmer's own capital is an allocation of profits: interest on borrowed capital is a charge against profits. But in neither case is it a charge against cost, and to include it in cost is to produce a figure which is not cost at all, but cost *plus* a certain margin of profit.

Another common error in statements of costs is the inclusion of a charge for *Management*. This has to be considered in the price, not in the cost, and, as indicated above, the amount earned by the farmer is a matter to be ascertained from the profits. If charges for the farmer's own management, as distinct of course from paid management, and for interest on his capital, are included as costs, the resultant figure represents the price at which the article can be sold to the consumer to give the necessary margin of profit to the producer. For the farm accountant to call it "Cost of Production" shows a lack of clear thinking or is an attempt to impose on the credulity of the public. In the long run both these charges have to be reckoned with if supply is to be maintained, but as

they are not actual cash transactions, and there is no basis for assessing them, they are not charges with which the cost accountant can deal.

A system of Management Book-keeping based on the foregoing principles, and carried out with figures supplied from adequate farm records, will furnish a complete economic review of the organisation of the farm for production, which should form the foundation both of the practice and of the teaching of agriculture. It is too much to expect that those already engaged in the industry can devote the time necessary to the study of the subject to make practical use of it in their daily work, but those responsible for the education of the coming generations of agriculturists can do no greater service to the industry than direct attention to the study of these too-long neglected subjects.

THE MODERN BEE-HIVE: ITS DEFECTS AND POSSIBILITIES.

TICKNER EDWARDES.

ONE of the mysteries of the country-side most puzzling to students of English village-life, is the decline—one might almost say the extinction—of cottage bee-keeping.

While well within the recollection of many hardly to be called old, the sight of a row of straw skeps in a village-garden was a common incident of a day's tramp in the country, a bee-hive is now the last thing the rural wayfarer would expect to come upon. He will see small fowl-runs in plenty, corners full of rabbit-hutches on stilts, and even pigstyes where farmers are altruistic enough to allow their labourers to instal them. For some unfathomable reason, however, the British cottager seems to have given up keeping bees, with the result, as all lovers of old Virgil's gentle craft well know, that many tons of valuable sweet-food are being annually lost to the people.

The mystery cannot be explained on the plea that our villagers are scared by the prevalence in recent years of the notorious "Isle of Wight" bee-disease. No doubt this affection, since its recrudescence some seventeen or eighteen years ago, has swept away thousands of bee-colonies, and many of the more timid hive-owners may have thus dropped out of the craft altogether; but cottage bee-keeping in this country was in full decline long before "Isle of Wight"—or Acarine—disease had been even thought of. The cause of the decline, if it be discoverable at all, must be looked for in quite another direction; and, in the writer's view, based on the experience of a long life spent in various southern English villages, the present unpopularity of bee-keeping among our cottage-folk must be largely attributed to a very simple and very human cause—a constitutional apprehensiveness in the rising generation.

The old bee-masters were as tough of heart as they were of skin. They thought nothing of a sting or two. To anyone qualified to judge, however, the fact is undeniable that among present-day village-folk, there exists very generally a mortal dread of the honey-bee's stiletto. The thing is obvious wherever you go. Scarce one but will tell you tales of father's or grandfather's prowess with bees, but when asked why they themselves do not maintain the family tradition in the

craft, they have only the one answer for you—a smile, a shrug of the shoulders, and a shake of the head. The children, it seems, are to go without this incomparable sweet, with its wonderful richness in vitamine, and be brought up on rickety beet-sugar, just because father will not risk his precious skin.

The production of honey and its hardly less valuable concomitant beeswax, is, however, by no means necessarily a hazardous business. All varieties of the honey-bee have their vicious strains, it is true, and many bee-keepers persist in retaining these strains in their apiaries for the reason, indisputable, that they are often splendid honey-makers. Yet it is equally true that bees of even temper exhibit just as good working qualities; and, setting bravado aside, no one, particularly one's neighbours, is obliged to put up with the nuisance of vindictive bees. In the course of the whole of last season a well-known apiarist who has studied this matter, received only two or three stings from his own bees, and these he ascribes entirely to his own carelessness. The writer, over the same period, can remember being stung only once, though his season's work included the frequent opening of hives, the taking of swarms sometimes in difficult situations, and the continual handling of honey-supers.

Safety and comfort in beemanship depend, in the first place, on having bees of quiet disposition; and, second and last and all the time, on deft, deliberate, gentle handling dictated by knowledge, together with abstention from fussy and needless interference with the bees. Probably the old maxim—that all knowledge worth having must be paid for—is as true in the attainment of proficiency in bee-craft as in anything else; but it cannot be too widely known that the production of honey and wax is no more likely to prove, nor necessarily to be regarded as, a prickly pursuit, than the cultivation of gooseberries. Indeed, as far as personal safety goes, the writer would far rather superintend a score of bee-hives than have the charge of one moderate-sized gooseberry-patch.

The avowed purpose of these observations is to advocate a return to the ancient and profitable pursuit of bee-keeping by our cottagers and smallholder class of country-dwellers, as a practical contribution to the elucidation of the problem of making life easier for the small man on the land. It is not intended, however, to deal with the details of modern bee-keeping methods, but rather to indicate a few of the broad principles on which the success of small apiculture depends.

The production of honey and beeswax is essentially a local industry. Very large apiaries located on one spot are economically unsound, for the simple reason that a given district, however rich in flora, is capable of employing profitably only a definite small number of colonies, seeing that the effective range of the honey-bee's flight is generally limited to a radius of, perhaps, a couple of miles. Bee-keeping pure and simple, is therefore, by a law of nature, reserved for the small man, and must ever remain so while our present system of agriculture lasts. There may come a time when planting exclusively for honey and wax production may develop into a payable project, and then, by degrees, large apiaries will probably oust the smaller ones altogether: but to consider that now would be a mere utopian "dealing in futures." The visible logic of the situation is to regard honey and beeswax as, what they essentially are at present, by-products of other rural commodities, and beemanship a sort of wholesale gleaning. For we are all gleaners at present, and nothing more, though it is just "with your will or by your will" in respect of the farmers: they must let our winged thousands pass whether they will or no. The bee-keeper, indeed, is in this enviable position—he pays nothing for his raw material, nothing in wages, and his labourers toil unremittingly for him while at the same time supporting themselves. His own contribution to the enterprise is merely a warehouse and factory costing a few shillings, a little of his spare time, and an odd corner of garden-space. No wonder it has become a truism that bee-keeping on modern scientific lines can be made to pay cent. per cent.

This statement is literally true, but it needs accurate definition and qualification. Bee-keeping will not pay unless a clean sweep is made of many erroneous notions, both new as well as old. There is perhaps no other pursuit in which such wide diversities, even contrarieties, of opinion and method exist among its professed exponents, all of whom, however, command a certain measure of success. At first this seems hopelessly paradoxical, until one realises the fact that the redoubtable honey-bee will "make good" to a certain extent under almost any conditions: if not because of the bee-keeper's methods, at least triumphantly in spite of them. All that, however, involves a great waste of bee-acumen and energy intolerable in these urgent days. The conclusion of the whole matter is that the deeper knowledge we get of the great unalterable principles underlying hive-life as exploited by the

bees themselves, the better we can make our colonies pay. It is to one in particular of the more outstanding of these principles, rather than to the general, accepted, practical daily routine of bee-craft, that we should now address ourselves.

It would be absurd, of course, to say that successful honey-production depends upon the kind of hive in which the bees are housed, although, hyperbolically, the phrase may be admitted. The dauntless nature of the honey-bee—her age-long triumph over difficulties set in her path by the ignorance of man—comes clearly to light under even the most cursory study of ancient beemanship. Nor does a review of bee-keeping methods in vogue in times comparatively modern, reveal any better understanding of the bees' requirements in the matter of hives as a result of nearer acquaintance with their true habits. It is a literal fact that there was no such thing as a bee-hive, in any sense worthy of the name, in existence in any country, until about three hundred years ago, when Sir Christopher Wren devised his octagon hive, inaugurating what is known as the "storification" principle. In bee-craft this was an epoch-making event, for Wren's hive afforded the domesticated honey-bee a thing which her winged sister of the wilds had easily secured for herself by building in a hollow tree—a domicile capable of expansion to meet the growing needs of the colony. But Wren's hive only provided for expansion *downwards:* that is to say, extension of the actual brood-nest, the nursery-quarters of the hive. It was left to a Scotsman, of characteristic racial intelligence, to discover, some century and a half later, that bees in a natural condition carry their surplus honey-stores *upwards.* And so the famous Stewarton hive, with its easily added upper storeys, and its resulting extraordinarily increased honey-yields, came into being.

The paramount stage, however, in the evolution of the modern bee-hive, was not reached until the year 1834, when the principle of the movable-comb hive was discovered by Major Augustus Munn, although the honour of priority for this invention is, it is believed, claimed by several other countries. The movable-comb hive at once transformed bee-keeping from a black art into an authentic though very immature and youthful science. The trouble in the present day is that the science of bee-keeping thus initiated, has, from the very first, been handicapped by an incorrigible, Peter Pan-like propensity of not being able to grow up. The movable-comb frame idea

was at once grasped by all bee-keepers, and as soon as it was discovered that these frames could be fitted with thin sheets of beeswax—impressed all over on both sides with a hexagonal pattern to represent cell-bases, which the bees would readily draw out into comb—then the craft came into possession of a thing which worked a complete revolution in the honey and wax industry. For the first time it then became possible to "manage" a hive—to add new frames to the brood-nest when the queen required more room for egg-laying; to do away with old clogged and useless combs and substitute good ones; to take combs of brood from over-populous colonies and give them to less forward ones; to control the breeding of drones by limiting the area of drone-comb in the hive, and by closer inter-spacing of the combs; to get at any part of the bee-city at a moment's notice for renewal of queens, or any other of a variety of operations; to prevent swarming by cutting out queen-cells, giving more room in the brood-nest by emptying existing combs of their honey, and adding comb-space for the queen; to make artificial swarms when required; and, above all, to keep up an inexhaustible supply of honey-combs, these being taken away as soon as filled, the honey in them removed by the centrifugal extracting machine, and the empty combs returned at once to the hive to be filled again. This latter possibility alone, by saving the bees the labour and time needed for comb-building just when both labour and time were most precious—during the height of the honey-flow—stamped the movable-comb hive as a veritable triumph of utility, and at once made it possible to obtain twice as much honey as heretofore from any given stock.

In so far as a full exploitation of the advantages of the movable-comb system is concerned, bee-keepers have indeed little with which to reproach themselves. In the matter of hives, however, we are in a very different case. It is here that bee-keeping science has kept its pristine babyhood almost intact. The straw-skep age was succeeded by an age of plain wooden box-hives; and the hive of the present day, for all its ingeniously contrived interior, remains a box and nothing more. Yet it should be a great deal more. It is vital, in fact, to the whole future prosperity of the craft that bee-keepers should generally recognise prevailing deficiencies in hive-construction and set about remedying them without delay.

The main fault of almost all hives obtainable commercially at the present time, is that their walls are too thin. This may, at first glance, seem an immaterial point, provided that the

hive is capable of excluding all moisture and draught—but this is not so. An indispensable quality in a good hive is that it should be in a very high degree both heat-retaining and heat-resisting, and in these qualities almost every hive at present on the market is lamentably wanting. If there be one principle more than another which the writer's long practical experience has established beyond a doubt, it is the necessity for double walls in a bee-hive. Nor is it enough to construct the hive of two shells, one fitting loosely within the other. This is better than the single-wall pattern, but it fails in several important particulars, even when the space between the two shells is packed with a heat-intercepting material such as chaff. Packing of this nature is liable to get damp, when it soon changes into a mass of corruption; and if merely left loose between the cases, it proves an unmitigated nuisance, should either of them need to be disturbed. Practicability rules all packing devices out of court, unless the material be securely enclosed. Indeed, its use is rendered superfluous, because dead-air—a perfectly confined empty space—is by far the best heat-retaining medium known. A good hive, therefore, at least as far as concerns the brood-nest, must have all its four sides composed of dead-air cavity-walls, preferably not less than three inches thick over all.

The writer is well aware that in insisting on this point, he is running counter to the notions, or want of notions, in the majority of bee-keepers, and is especially likely to embroil himself with "the trade." It is admitted that a clever and careful bee-master can make bees thrive to a certain degree in almost anything: admitted also the logic—though not the morals—of the position that while single-walled hives, easy to construct, can be readily sold, it would be folly to push the sale of another article, however superior, which is troublesome and expensive to make. Despite the trouble and cost, however, stress must here be laid not on the superiority alone of double-walled hives, but on the downright necessity of them, where the bee-keeper looks for the best return on his outlay.

In such hives, properly designed and put together, it is definitely claimed that the bees will remain healthier at all seasons, will consume a smaller amount of food during winter, will make more speedy progress in numerical strength throughout the spring, and, because they thus reach the brink of the summer nectar-flow with a larger population of workers, will certainly collect more honey for their owner. The cottager and smallholder, therefore, to whom these observations are

mainly addressed, is earnestly counselled to adopt this system of housing his bees as one of the principal points in profitable apiculture.

Indeed, it is scarcely possible to extract the fullest advantage from the modern movable-comb hive system under any other procedure. Damp is the chief enemy of hive-life, and probably the main exciting cause of nearly all diseases of bees. A stock housed in a brood-chamber which can be kept both warm and dry, and at the same time freely ventilated, will retain health and thrive in the face of continued adverse weather conditions, where colonies housed in the single-walled hives will come hopelessly to grief. The reason for this is not far to seek. The arguments follow each other in a vicious circle. Single walls mean cold walls. Cold walls mean perpetually damp walls as regards their insides, because the warm vapour incessantly given off by both bees and ripening honey, condenses on them; whereas with double walls, the interior surface of which remains as warm as the rest of the brood-chamber, this vapour passes harmlessly out of the hive. Damp walls mean damp combs and an incessant lowering of temperature, which the bees try to counteract by extra feeding; and extra feeding, combined with inaction during periods of confinement to the hive, means dysentery and possibly worse.

When we make the walls of our hives perfectly non-conducting to heat, we cut at the root of all this mischief. Then, instead of a vicious circle of arguments, we have a benevolent one. Double walls mean warm walls. Warm walls mean permanently dry walls, and these again ensure a whole hive-interior dry and of uniform temperature. In winter the bees are comfortable, their hibernation is more complete, and so they require less food. Brood-raising in early spring forges ahead betimes. In the summer heats the hive remains cool, and the tendency to swarming is lessened. Moreover, because the hives keep dry under all conditions, the bee-keeper can leave their entrances wide open at all times of year, thus providing abundant means of ventilation; and plenty of fresh air means hardy, vigorous, disease-resisting bees. It stands to reason that bees of that fettle must always prove the best honey-makers.

In the end, therefore, at the cost of a little extra trouble and timber, the cottager has not only given his children an unlimited supply of body and brain-building food throughout the year, but has probably paid his rent, and butcher's and baker's bills into the bargain.

IMPROVEMENT OF GRAZED PASTURES BY MANURING.

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GENERAL conclusions obtained from the results of a series of experiments on the improvement of hill and peaty pastures laid down by the Department of Agriculture, University College of North Wales, Bangor, have been published by that Department in pamphlet form.*

These experiments were made in 1913, 1914 and 1915, and were all on a uniform plan, as shown in Table I.

Table I.—Plan of Experiments.

Manure per Acre.

Plot	I.	10 cwt. Basic Slag, 42 per cent. total phosphate, 33·6 per cent. citric soluble phosphate.
„	II.	10 cwt. Ground Gafsa Phosphate, 62 per cent. total phosphate, 22·4 per cent. citric soluble phosphate.
„	III.	6 cwt. Superphosphate, 30 per cent. phosphate.
„	IV.	No Manure.
„	V.	Superphosphate as for Plot III, with the addition of 20 cwt. Ground Lime.
„	VI.	20 cwt. Ground Lime.
„	VII.	36 cwt. Ground Limestone.

The plots were also cross-dressed with a potassic manure, viz., 1½ cwt. sulphate of potash per acre in the earliest experiments and 6 cwt. of kainit per acre in the later experiments.

These experiments were made at a number of centres throughout North Wales. Although valuable results were obtained, at most of the centres the ground was not sufficiently uniform to give reliable results from botanical analyses. Only at five centres, therefore, were botanical analyses of the herbage made, all primarily in the fourth summer of the experiments. At one of the centres, the results were practically nil, while the botanical results only showed that leguminous plants were entirely absent from the herbage.

At a second centre, where the soil was a neutral peat and the herbage approximately that of the fen type, there was no change which might be considered to be an agricultural

* The latest pamphlet, "The Improvement of Rough Pasture," was issued early in 1920. The writer is indebted to Professor R. G. White for particulars of these experiments. The work here recorded was done while the writer was attached to the Department of Agriculture at Bangor.

improvement, and the chief botanical result was a distinct increase, both in number and vigour, of *Juncus subnodulosus*, following the application of basic slag, superphosphate and superphosphate with ground lime. The most interesting feature of this experiment, however, was that ground Gafsa phosphate had no effect whatever.

At the other three centres, very marked results were obtained, but, unfortunately, owing to some doubts as to the uniformity of the soil, three of the plots at Centre A and one at Centre C have been ruled out.

All the results given here were obtained by the Percentage Frequency method. This method has the effect in some cases of obscuring some important features, particularly the effect of treatment upon the density of the herbage as revealed by the number of plant units per unit area. For this reason, aggregate results are given in terms both of plant units per unit area, and percentage frequency, the unit area selected being 36 sq. in. To give detailed analyses would mean very long tables, and although these would be interesting, the results for many plants occurring only in relatively small quantities would not be sufficiently definite to be of much value. Only the most important plants are, therefore, included in the detailed results.

The Effect of Potash.—At none of the centres where botanical analyses were made was there any indication that potash had any appreciable effect. At another centre, however, on well-drained, deep, acid peat, it had a marked effect. On the " No manure " plot, it had the effect of increasing Knapweed (*Centaurea nigra*) in a very conspicuous manner, but this was not seen where the potash was used with other manures. The greatest improving effect was obtained when potash was used with superphosphate and ground lime, but it was also clearly seen on the basic slag, Gafsa phosphate, and superphosphate plots.

No marked difference could be seen between the basic slag and Gafsa plots, although White Clover was more developed on the latter. Both were obviously superior to the superphosphate plot, which, however, showed considerable improvement over the unmanured plot.

All three plots showed a marked increase in the number of plant units per unit area. It is interesting to note (Table II) that the number of grass units increased equally on the basic slag and Gafsa plots. There was a considerably greater increase in grass units on the superphosphate plot, but the

Centre A: Penlan, Llangollen, Denbighshire:—

Field: Old pasture in poor condition, continuously grazed, naturally well-drained.
Soil: Shallow, medium loam on shaly brash.
Altitude: 1,250 feet.
Rainfall: Probably about 50 inches.

Table II.—Aggregate Results for Centre A. Fourth Summer.

	Manure used :—	Basic Slag.	Gafsa Phosphate.	Superphosphate.	None.
Plant units per unit area	Gramineæ -	258	258	290	200
	Leguminosæ -	66	107	40	8
	Miscellaneous	28	27	27	26
	Total - -	352	392	357	234
Percentage Frequency	Gramineæ -	73·3	65·8	81·2	85·5
	Leguminosæ -	18·7	27·3	11·2	3·4
	Miscellaneous	8·0	6·9	7·6	11·1
		100·0	100·0	100·0	100·0

increase of leguminous plants was least on this plot. There was actually very little change in the miscellaneous plants, but owing to the other changes involved they would appear from the percentage results to have decreased.

At this centre, Gafsa phosphate clearly had the greatest effect on the aggregate botanical composition of the herbage, while its effect upon the leguminous plants was considerably more marked than that of basic slag.

Table III.—Some Detailed Percentage Results for Centre A. Fourth Summer.

	Basic Slag.	Gafsa.	Super-phosphate.	None.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Agrostis tenuis - -	45·7	40·6	59·0	73·1
Holcus lanatus - -	6·8	4·0	5·8	2·1
Festuca rubra - -	6·5	8·3	6·1	3·0
Cynosurus cristatus -	9·6	6·8	3·0	2·6
Anthoxanthum odoratum	4·5	6·1	6·6	4·3
Trifolium repens - -	14·2	25·0	10·2	1·7
Lotus corniculatus -	4·5	2·3	1·0	1·7

One of the chief features shown by Table III is that the proportion of Bent grass was decreased by all three manures, while that of the other grasses was increased. The extent of the change varied considerably in some cases. Gafsa phosphate gave a remarkable increase of white clover.

Centre B: Ffridd, Rhyd-ddu, Carnarvonshire:—

Field: Very old pasture, continuously grazed, good natural drainage.
Soil: Thin acid peat on local drift.
Altitude: 900 feet.
Rainfall: Very high (probably about 100 inches).

Owing to a very marked change observed in the herbage of some of the plots at this centre by the sixth summer, the percentage frequency examination was made both in the fourth summer and in the sixth.

Table IV.—Aggregate Results for Centre B. Fourth and Sixth Summers.

		Manure used :—	Basic Slag.	Gafsa phos-phate.	Super-phos-phate.	* None.	Superphosphate with Ground Lime.	Ground Lime.	Ground Lime-stone.
FOURTH SUMMER.	Plant units per unit area	Gramineæ ...	328	298	266	229	293	277	275
		Leguminosæ...	95	93	75	13	94	70	27
		Miscellaneous	31	15	22	23	24	18	16
		Total ...	454	406	363	265	411	365	318
	Percentage Frequency	Gramineæ ...	72·2	73·4	73·3	86·4	71·3	75·9	86·5
		Leguminosæ...	20·9	22·9	20·7	4·9	22·9	19·2	8·5
		Miscellaneous	6·8	3·7	6·1	8·7	5·8	4·9	5·0
		Total ...	99·9	100·0	100·1	100·0	100·0	100·0	100·0
SIXTH SUMMER.	Plant units per unit area	Gramineæ ...	280	290	268	208	320	301	304
		Leguminosæ..	18	6	4	9	54	66	46
		Miscellaneous	47	23	31	15	31	24	27
		Total ...	345	319	303	232	405	391	377
	Percentage Frequency	Gramineæ ...	81·2	90·9	88·4	89·7	79·0	77·0	80·6
		Leguminosæ...	5·2	1·9	1·3	3·9	13·3	16·9	12·2
		Miscellaneous	13·6	7·2	10·2	6·5	7·7	6·1	7·2
		Total ...	100·0	100·0	99·9	100·1	100·0	100·0	100·0

* Average figures for three untreated plots. The figures for these three plots varied but little.

In the fourth summer, the most improved plots appeared to be those on which basic slag, Gafsa, and superphosphate with ground lime were respectively applied, but improvement was also noticeable on the superphosphate and ground lime plots. On the ground limestone plot improvement was very small. Table IV shows that at this time there was also a very marked difference in the herbage of the plots. On the most improved ones, there was a very marked increase in the number of plant units per unit area, especially on the basic slag plot, and a striking feature is the similarity of the figures for Leguminosæ on the three most improved plots. In the percentage results, this similarity is obscured and the figures for leguminous plants are relatively near each other for the five most improved plots.

Similarity between the figures for the ground lime and superphosphate plots is also observable.

By the sixth summer, the basic slag, Gafsa, and superphosphate plots were in a bad state. The first two plots had a patchy appearance, with a considerable proportion of practically bare soil, while the superphosphate and the unmanured plots appeared to be exactly alike. The superphosphate with lime and the ground lime plots were, on the other hand, in excellent condition, while the ground limestone plot was much improved. As will be seen from Table IV, the unmanured plot had suffered relatively little change in the interval, but the change in Plots I, II and III was very marked, the leguminous plants having all but disappeared. At the same time, there was a decrease of these plants on the superphosphate with lime plot, but the percentage composition of the herbage was still good. The change on the ground lime plot was relatively small, but there was a considerable increase in the gramineous plant units per unit area. These aggregate figures do not show any great difference between the first three plots in the sixth year, but, as will be seen from Table V, the superphosphate plot was much more nearly similar to the unmanured plot than either the basic slag or the Gafsa plots.

Table V.—Some Percentage Frequency results for Ffridd Obtained in the Fourth and Sixth Summers after Treatment.

	Manure used :—	Basic Slag.	Gafsa Phosphate.	Superphosphate.	* No Manure.	Superphosphate with Ground Lime.	Ground Lime.	Ground Limestone.
Fourth Summer.	*Agrostis* spp.	33·8	31·9	17·7	22·7	21·9	16·1	15·9
	Festuca ovina	17·4	25·9	37·0	41·9	34·6	38·9	48·2
	Molinia cærulea ...	0·4	0·5	3·9	7·1	2·7	3·4	7·5
	Anthoxanthum odoratum	5·3	2·6	3·6	2·9	1·0	3·2	2·7
	Trifolium repens ...	20·9	22·9	20·7	4·9	22·9	19·2	7·6
	Potentilla erecta ...	0·5	0·2	0·4	2·0	1·5	1·0	1·6
	Sagina procumbens ...	2·4	1·2	—	0·5	2·4	1·9	1·2
Sixth Summer.	*Agrostis* spp.	17·1	58·4	21·0	18·8	28·1	22·2	22·8
	Festuca ovina	6·1	5·3	27·9	40·5	39·3	36·6	35·0
	Molinia cærulea ...	2·0	0·6	4·1	4·9	3·3	2·0	4·0
	Anthoxanthum odoratum	5·5	1·9	—	2·3	—	1·5	2·7
	Trifolium repens ...	5·2	1·9	1·3	3·9	13·4	16·9	12·2
	Potentilla erecta ...	1·2	0·9	0·2	0·6	2·0	2·8	2·7
	Sagina procumbens ...	2·3	2·5	0·4	—	2·2	0·8	0·5

* Average for three untreated plots, one at each end of the series, the other in the centre. The figures for these three plots varied but little, *e.g.*, *Agrostis* :— 23·8, 23·7, 20·5 per cent.

It would appear from the figures in this table that the balance of the herbage on the slag and Gafsa plots was so upset that it was unable immediately to return to its original state, but immediate reversion was possible on the superphosphate plot when the effects of the manure were exhausted.

The effects of slag and of Gafsa phosphate are particularly marked upon some plants. It is curious to note that *Agrostis* spp. were much increased even by the fourth summer, when the plots were in excellent condition, while by the sixth summer there was a further increase, although the plots were then in a very poor condition. Some of the other plots showed very little change or decrease by the fourth summer, and, except on the superphosphate with ground lime plot, the development of *Agrostis* was not far from normal in the sixth summer. *Festuca ovina* was even more markedly affected by slag and by Gafsa phosphate, but on the other plots it suffered relatively little. There was a marked decrease of *Molinia* on the most improved plots, but relatively little on the others.

From these results, it would appear that, under the conditions of the experiment, (1) a marked improvement may be accompanied by such a change in the botanical composition of the herbage that, when the direct effect of the manure has been exhausted, the herbage may become even poorer than it was originally; (2) an increase in *Agrostis* spp. may accompany a marked improvement; (3) a decrease of *Festuca ovina* may also occur when an improvement takes place, and, in extreme cases, may almost disappear as a result of treatment which has given a great improvement; (4) an increase in *Trifolium repens* accompanies an improvement, while a decrease accompanies a deterioration ; (5) *Sagina procumbens* shows an increase with improvement, and may maintain or even improve its increase with the deterioration which follows improvement, if the general balance has been so upset that direct reversion to original condition is not possible.

Centre C: Ffyddion, near Caerwys, Flintshire:—

Field: Very old pasture, continuously grazed, rather flat, but naturally well-drained.
Soil: Mostly rather heavy loam on clay drift over limestone.
Altitude: About 650 feet.
Rainfall: About 40 inches.

The plots at this centre were also examined by the Percentage Frequency method in the fourth summer after the application of the manures. Part of Plot VII was on rather lighter soil than the other plots, and the results obtained are not, there-

fore, included in the tables. Results on the "No manure" plot are the average for two such plots, one ground adjoining the basic slag plot and the other in the position shown in the tables.

Table VI.—Aggregate Results for Centre C. Fourth Summer.

	Manures used :—	Basic Slag.	G fsa Phosphate.	Super-phosphate.	None.	Super-phosphate with Lime.	Ground Lime.
Plant units per unit area	Gramineæ -	380	387	256	220	313	191
	Leguminosæ -	87	107	50	7	69	12
	Miscellaneous	33	27	34	59	44	45
	Total - -	500	521	340	286	426	248
Percentage Frequency	Gramineæ -	76·0	74·3	75·3	76·9	73·5	77·0
	Leguminosæ -	17·4	20·5	14·7	2·4	16·2	4·8
	Miscellaneous	6·6	5·2	10·0	20·6	10·3	18·1
	Total - -	100·0	100·0	100·0	99·9	100·0	99·9

In the fourth summer (and in other years also) it was clear from the appearance of the plots that the most successful were, as usual, those on which basic slag, Gafsa phosphate, and superphosphate with ground lime had been applied. The ground lime plot showed no improvement whatever, and, if anything, it was rather poorer in appearance than the untreated ground. Ground limestone showed a very slight improvement, while the improvement on the superphosphate plot was well marked, although the line between it and the adjoining Gafsa plot was easily traceable. In this case, again, the results show (Table VI) that on the most improved plots there was a very marked increase in the number of plant units per unit area. Differing from the other centres, however, the miscellaneous plants were much affected in the aggregate, but in the original pasture they stood at a relatively very high figure. The decrease of these plants on certain plots was, however, so well distributed amongst the various species that the changes in individual species were generally insignificant.

It is of some interest to note that, in spite of the underlying rock (at no great distance from the surface), the greatest change was brought about by Gafsa phosphate.*

Table VII shows that here, as at Centre B, a marked improvement may be accompanied by an increase of Bent grass, although there was no marked change on the superphosphate with lime plot.

*At one centre only was Gafsa phosphate inferior to basic slag, and that was on a deep neutral peat in Anglesey. At this centre Gafsa had no effect whatever, while slag had a marked effect.

Red fescue increased on the most improved plots and also on the ground lime plot. On close examination, it was found that the appearance of the grass differed greatly in the two cases. On the ground lime plot the stems were purplish and the grass unattractive, while on the improved plots it was of excellent colour and well grazed.

The two grasses which seem to have been affected most are *Sieglingia decumbens* (*Triodia*) and Quaking Grass. Both were greatly reduced on the most improved plots. Even ground lime had caused some decrease.

Yorkshire Fog, on the other hand, increased on the more improved plots, but not in proportion to the extent of the improvement. The increase on the superphosphate with lime plot and the decrease on the ground lime plot appear to indicate that, under the conditions of the experiment, treatment had a special effect upon this grass.

As usual, a marked improvement was accompanied by an increase in Leguminosæ, especially White Clover, and this increase was exceptionally marked on the Gafsa plot.

Table VII.—Some Percentage Frequency Results for Centre C. Fourth Summer.

	Basic Slag.	Gafsa Phosphate.	Super-phosphate.	None.	Super-phosphate with Ground Lime.	Ground Lime.
Agrostis tenuis	43·8	39·5	41·3	34·5	36·9	39·1
Festuca rubra	15·8	20·9	13·2	12·5	18·5	19·8
Anthoxanthum odoratum	4·4	4·4	3·8	4·2	3·5	4·8
Sieglingia decumbens ...	1·6	0·6	2·6	6·5	0·7	4·8
Holcus lanatus	5·6	6·4	6·2	4·5	11·0	—
Briza media	0·8	1·5	6·7	13·7	2·6	8·5
Trifolium repens ...	15·6	20·0	13·5	1·3	15·5	2·4
Lotus corniculatus ...	1·8	0·5	1·2	1·2	0·7	2·4

Summary and Conclusions.—The main object of this article is to place on record and render available some botanical data obtained from manurial experiments under three different sets of conditions on very poor pastures in North Wales. For this reason, no attempt has been made to discuss the results at all fully. From the data given, however, the following conclusions may be drawn:—

(1) At all three centres a very marked improvement was observed on some of the plots. (This was, however, not the case at some centres where similar experiments were carried out.)

(2) At each centre, a marked improvement was accompanied by a marked increase in the total number of plant units per unit area, and this increase was apparently in proportion to the extent of the improvement.

(3) Marked improvement was also invariably accompanied by a corresponding increase in the proportion of White Clover.

(4) In one case, improvement was accompanied by a decrease of the proportion of Bent grass, which, however, stood originally at a high figure. At the other two centres, the proportion increased as a result of improvement.*

(5) At one centre Sheep's Fescue was profoundly affected by basic slag and by Gafsa phosphate.

(6) In general, equal quantities of high-grade basic slag and ground Gafsa phosphate gave nearly equal results, but the botanical data strongly suggest that Gafsa phosphate was the more effective. In one case, improvement by means of these manures was quickly followed by a great deterioration, and it would appear that the changes induced by them in the first instance were so great that the pasture was incapable of reverting directly to its original condition.

(7) Superphosphate with ground lime gave very good results, which were, perhaps, not quite so good as those given by the two manures already mentioned. At the particular centre referred to above, there was not such rapid deterioration as with basic slag and Gafsa phosphate.

(8) Superphosphate alone was in all three cases inferior to the manures already mentioned, but it produced a considerable improvement. With this manure, the deterioration which followed the initial improvement at Centre B consisted of a reversion of the herbage to its original state.

(9) Only at one centre did ground lime alone effect an improvement.

(10) Results for ground limestone are given for one centre only, where it was more effective than at any other centre. Even here, however, its action was very slow.

* Cf. Stapledon, R.G.: "Pasture Problems: The Response of Individual Species under Manures." *Jour. Agri. Sci.*, Vol. VI. Part IV, 1914.

MARKETING OF FRUIT.

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IN considering this subject it must not be forgotten that in the early days the bulk of the fruit was grown in the vicinity where it was needed and the transport was more or less limited to a few miles. For this reason there sprang up many localised industries in fruit growing near the populated areas. Questions of grading and packing and the kind of packages necessary did not weigh very heavily with the producer of the fruit, and he used such packages as were convenient. The Kentish and Middlesex men found that round baskets, hampers and half-bushel baskets were the most convenient for trade with the London shops, whereas Evesham fruit growers preferred to use a square basket of the type now known as the Evesham pot. Other districts used flats or barrels. All proved equally satisfactory for the carrying on of this purely local business.

In more recent times, with the advent of steam engines and railways in the country, making the transport of fruit possible over long distances, the limitations of districts suitable for the production of fruit no longer obtained. Soil and climate then became the more important factors, and where these were suitable for the production of fruit the industry grew, and important fruit growing areas were developed in many parts of the country. Even growers engaged in the cider industry in the West of England were attracted and turned their attention to the possibility of the production of table fruit instead of cider fruit. In spite of this development the supply of home grown produce was seldom, or never, sufficient to meet the ever-increasing demand for fruit by the urban dwellers and workers of the large industrial centres.

The introduction of powerful and fast ships made it possible for growers so far away as Canada, South America, Australia and Tasmania, to send to our markets certain varieties of fruit to help to satisfy this demand, by supplying varieties which came on to the markets after the bulk of the home-grown fruit had been consumed.

Imported Fruit.—For shipment purposes growers in other countries soon discovered the futility of sending anything but good class sound fruit, packed in such a manner as to reduce the risk of bruising to a minimum. Thus they evolved the system of grading and packing, and brought into use the wooden

boxes and barrels now so well known on the markets. Legislation fixing certain standards of grades and packages, and measurements of boxes and barrels, is of more recent introduction. It has no doubt stimulated and hastened forward a movement which was started voluntarily.

The exporters soon realised also, that to secure repeat orders similar classes of consignments should be branded or labelled with distinctive and guaranteed marks, and for continued business a large bulk of a very few varieties would be needed. Experience in marketing soon established these facts, and growers in other countries soon adapted their industry to meet these conditions.

A study of the figures showing the imports into this country makes it clear that the methods adopted in marketing imported fruit has given satisfaction. It is true that many of these consignments reach this country after the home crop has been consumed; but a portion, and an increasing portion, is marketed here in competition with the home-grown fruit.

The disadvantage in respect of transport to which the imported fruit is placed should serve as a big handicap, yet because of the manner of its presentation such fruit is in favour on the markets, and has in fact made considerable headway in securing a considerable proportion of the trade. For example, in 1919 the apple crops in the British Isles were exceedingly heavy in all districts, yet notwithstanding this, 2,967,284 cwt. were imported from abroad between August and December. These imported apples, in preference to the home-grown produce, were eagerly bought up by retailers, in many instances at prices in excess of those realised for our best samples. This fact illustrates the standing in the British markets that has been secured by the imported produce. It has been stated by wholesalers that as soon as the foreign crop arrives they have considerable difficulty in finding buyers for the home produce, simply because retailers and others prefer a standard article on which they can rely to an article which may, or may not give satisfaction.

Home-grown Fruit.—Something must be wrong with the home industry that such a state of affairs can exist. Is it that the English varieties of fruit are inferior to those grown elsewhere? Or is it that the fruit is presented to the public in a less attractive manner than the imported? Or do both these factors operate together to the disadvantage of the home-grown article?

The majority of people would admit truthfully that well-grown English fruit, with its thin skin, juicy flesh, and pleasing flavour,

is probably as fine a fruit as is produced anywhere in the world, and much superior in flavour to that produced in places where the atmosphere is drier and the heat of the sun more intense. The fault appears to be not in the article but in the methods of packing and marketing—the manner in which it is presented to the public. It therefore becomes necessary to consider the present methods of marketing and distribution, and to see where improvements can be made, what direction reforms should take, and by whom they should be made.

There are, of course, growers in this country who not only pick their fruit carefully, but grade it into convenient sizes before packing into marketable parcels. Such growers experience little difficulty in marketing most of their produce, but their number is not large. Few people in England have seen apples put through grading machines before being properly packed, for even in Kent the practice even now is by no means general. The usual orchard scene with which one is so familiar, especially in the orchards of Somerset and Devon, is that of apples being shaken down from the trees, and picked up and thrown into barrels; or gathered by hand into baskets and then poured in bulk into barrels. Large and small, sound and blemished, perfect and ill-shaped fruit, are all mixed in the same package. When full the package is roughly handled to shake the fruit down tightly, straw is placed on the top and the package is ready for market. Seldom are the packages weighed, for it is generally accepted that the weight of apples in any given receptacle is known, and is constant irrespective of the variety.

Late varieties gathered in bulk and stored in heaps covered with straw in lofts, keep moderately well. The packing of these for the market shows little or no advance on those marketed direct from the orchard.

Better packing and better delivery prevails in the few cases where the grower deals direct with the consumer or the retailer, but the quantity of fruit that is marketed in this way is small compared with that sent to the markets proper. In most cases growers generally are not inclined to treat their packing seriously, the result being that the salesman has either to sell the produce cheap, or to waste time in a busy market and have the goods re-sorted and packed with dear labour. Neither course gives satisfaction to the grower. The retailer buying the unsorted goods is generally dissatisfied. He often finds the best on the top, and a lot of small inferior fruit at the bottom. Possibly too the packages are less in weight than he was expecting. It would not be fair to blame the grower for all these offences, though

no doubt he could, with a litle care, have rectified many of them; for the packages may during transit have been interfered with on rail, and the increase in pilfering during recent years is regrettable. Indeed, complaints as to the transport by rail of fruits continue to increase, and the whole system is giving general dissatisfaction. Transport by motor ensures prompt delivery, less handling of the packages, and consequent less bruising of the fruit, and providing the cost is not materially different this system is likely to be extended for marketing fruit in future.

Sufficient has been written to indicate that reform measures are necessary, and that the growers, the distributors, and transport companies can all assist in helping with them. They should be such as to secure the marketing, in proper packages, of well-graded fruit, to satisfy the just demands of the consumer. Dealing first with the grower's reforms, the question of varieties arises.

In the past growers have been in the habit of planting a few sorts of local importance, and the fascination of multiplying these is clearly shown by quoting as an example, that of an orchard in the West of England no larger than an acre and a half, where no less than 17 different kinds were planted. It is true that some varieties do better than others in certain localities, and that some elasticity must be afforded to the grower when making his selection for planting: but it seems important that the whole industry should meet together to draw up a list of varieties which may be regarded as of commercial importance. It is not expected that all of these would do well in any one district, or in all classes of soil, but most growers would be able to make a selection to suit their needs. If this scheme were adopted, varieties which are useless or are unknown on the market, would in time be eliminated, and a large quantity of the agreed kinds would be produced. The public generally would become acquainted with these kinds and ask for them. Salesmen and retailers could rely on a large bulk of a few sorts and would be in a position to give repeat orders.

The varieties included in the list should be subject to alteration from time to time, in order that new introductions of decided promise might be added, and worn out or unprofitable sorts struck off.

When the grower has planted the varieties of fruit that are required by the consumer, he should endeavour, by the adoption of up-to-date hygienic measures in his orchards, to produce clean fruit free from blemish, and in picking to handle it with care, so that it may be presented to the consumer in a fit manner.

RESEARCH IN ANIMAL BREEDING.

III.

R. C. PUNNETT, F.R.S.
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In the previous articles of this series, published in the April and May issues of the JOURNAL, *Prof. Punnett dealt with the coat colours in cattle, and the crossing of polled with horned cattle as illustrations of simple Mendelian inheritance.*

THE factorial hypothesis of heredity is, if substantiated, of fundamental importance to the breeder, for it at once raises his operations from an empirical to a scientific plane. It brings certainty where before was only conjecture. Consequently, when animal breeding experiments were started on the University Farm at Cambridge in 1910, it was felt that among the first things to do was to choose one or two cases of apparent blending inheritance, and to study them critically in order to ascertain whether they could be interpreted on the factorial hypothesis. The choice of material was limited to small animals, for reasons of economy. This, however, was no drawback, for small animals can be bred in reasonably large numbers; and we can hardly doubt that what we learn from them is applicable to bulkier and more costly stock. Our work has, therefore, been entirely with poultry and rabbits.

One of the most extensive series of experiments undertaken with poultry was designed to investigate the inheritance of weight. For this purpose two standard breeds were chosen, differing markedly in size, but not so much so as to prevent natural crossing. For the larger breed we selected the Gold Pencilled Hamburgh, and for the smaller one the Silver Sebright Bantam (Plate 1, Fig. 1). As will appear later, the reason for choosing these particular breeds was to make use of the same material for the elucidation of more than one problem. From the point of view of size the two breeds differed sufficiently, for the average weights of cocks and hens respectively were for the Hamburgh about 1,400 and 1,100 grammes, while for the Sebright they were about 850 and 650 grammes. Roughly the Sebrights were about 3/5ths of the weight of the Hamburghs.

The first cross birds were intermediate in size, though approximating to the larger breed, the cockerels averaging about 1,200 grammes, and the pullets about 950 grammes. From several

FIG. 1.—Gold-pencilled Hamburgh cock and Silver Sebright hen

FIG. 2.—Small and large F_2 cockerels.

FIG. 3.—Small and large F_2 pullets.

pens of such F1 birds, an F2 generation of 239 birds was raised, viz., 113 cockerels and 126 pullets. In contrast to the uniformity of the F1 generation these F2 birds exhibited a wide range of variation. As shown graphically in Fig. 6, the weights of the cockerels varied from about 550 to 1,600 grammes, while those of the pullets were from 500 to 1,200. The majority of the birds in this generation were between the weights of the original parental breeds, but a few were larger than the Hamburgh, and a few were smaller than the Sebright (Plate 1, Fig. 2 and 3). Here we have an apparent case of blended inheritance, with fair uniformity in F1, and a wide range of variation in F2. Can such a case be interpreted in terms of the factorial theory? An interpretation is possible if we suppose that the Hamburgh and the Sebright differ in several factors, each of which affects the weight of the bird. The explanation of such cases was first given by Nilsson-Ehle, the well-known Swedish plant breeder, to account for the results of certain of his experiments with wheat and oats at Svalof. The closeness with which the theory fitted his results left little doubt of its being a true interpretation. The essential part of his idea is that a similar effect may be brought about by more than one factor, though such factors are independently transmitted in the usual way.

Let us suppose that there are several similar factors *A*, *B*, *C*, *D*, &c., which influence the weight of poultry. When a bird possesses none of these factors it will be the smallest type of bantam; when it contains *A* it will be rather larger; when it contains both *A* and *B* it will be larger again, and so on until the largest breed is reached, which must be supposed to contain a full collection of these factors. Again, let us suppose that when a bird is pure for one of these factors, *i.e.*, when it has received it from both parents, the effect on its weight is greater than when it has received it from one parent only. In other words we suppose that dominance is not complete, and that the *Aa* bird, for example, is not so heavy as the *AA* bird of otherwise similar constitution. And so also for the other weight factors, *B*, *C*, *D*, &c.

Now if we suppose that the Hamburgh contained three such factors, *A*, *B* and *C*, while the Sebright contained a different one, viz., *D*, we obtain a theoretical explanation which covers the observed facts :—

(1) The uniformity of the parental breeds for a markedly different average weight.

(2) The uniformity of the F1 birds in weight.

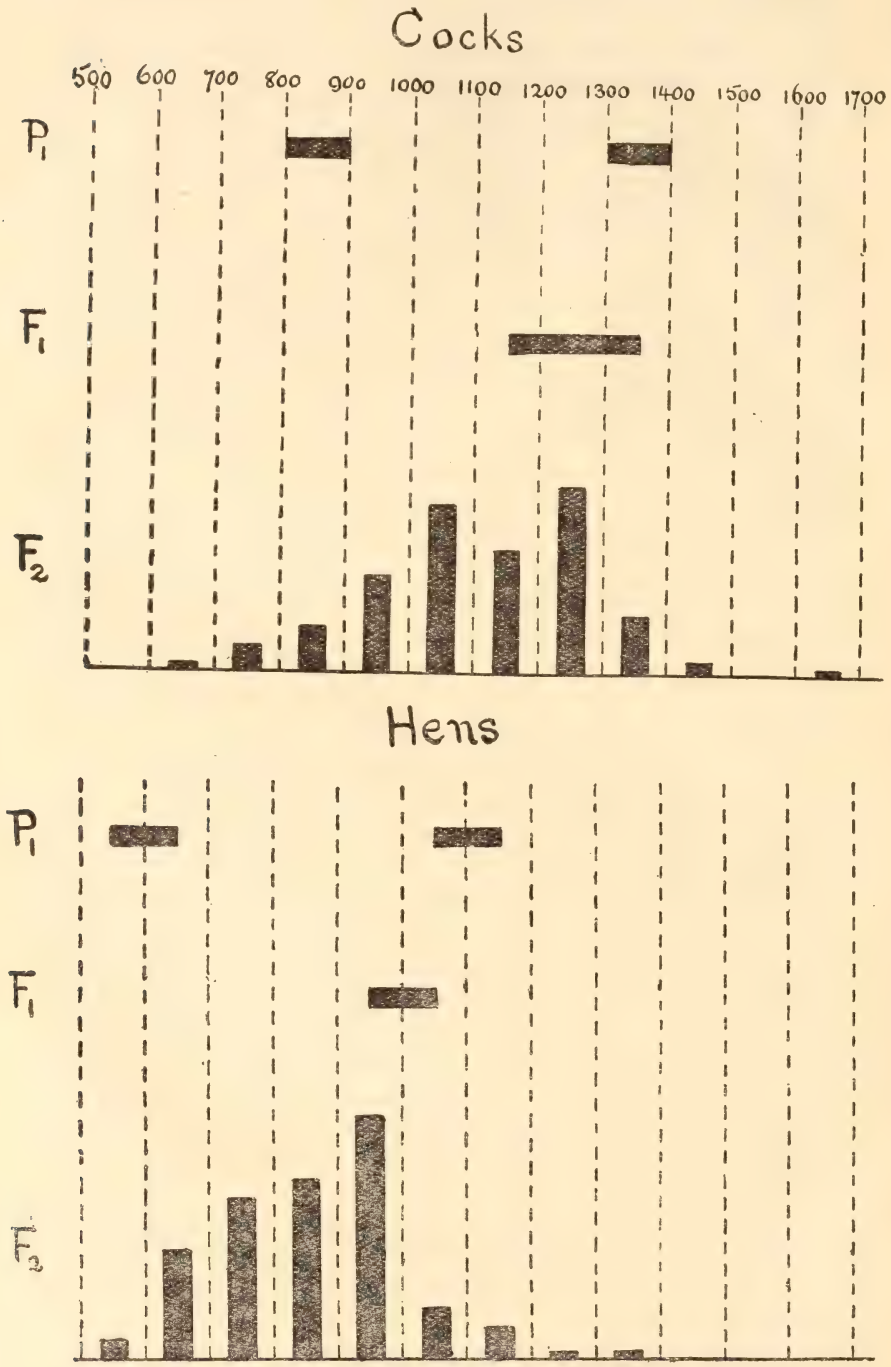

FIG. 6. Illustrating the inheritance of weight in the Hamburgh-Sebright cross. The figures at the top represent the weight in grammes. For further explanation see text.

(3) The approximation of the F1 birds to the weight of the larger parent.

(4) The great variation in weight shown by the F2 generation.

(5) The production in F2 of birds larger than the Hamburgh, and of others smaller than the Sebright.

For if the Hamburgh were *AABBCCdd*, and the Sebright *aabbccDD*, the F1 birds must all be *AaBbCcDd*. They will be uniform, and at the same time, since they contain a dose each of 4 factors, they will not on our hypothesis be much lighter than birds which, like the Hamburgh, contain a double dose of 3 factors. When, however, such birds are bred together they should give an F2 generation showing great variation, for such F1 birds should produce germ cells of 16 different kinds with respect to the four size factors involved, viz. :—

ABCD	*AbCD*	*aBCD*	*abCD*
ABCd	*AbCd*	*aBCd*	*abCd*
ABcD	*AbcD*	*aBcD*	*abcD*
ABcd	*Abcd*	*aBcd*	*abcd*

From the meeting of two such series of germ cells it is clear that all sorts of sizes will result; but the reader who wishes to follow out these possibilities in detail must be referred to the original paper.* It should, however, be noticed that such a combination as *AABBCCDD* will occur, in which a bird is pure for all 4 factors. Birds of this combination, as well as others, such as *AABBCCDd* or *AABBCcDD*, should be heavier than the Hamburgh. Again, we may have the combination *aabbccdd* in which none of the 4 factors are found. Such birds must be smaller than the Sebright.

The theory is in accordance with the series of facts to be explained that was set out on pp. 253 and 255. It can, however, be subjected to further test. The very large F2 birds, and the very small ones should, on the theory, breed true to size. Lack of opportunity prevented the testing of the biggest ones, but a pair of the smallest F2 birds (shown on Plate 1, Fig. 2 and 3) was mated together, and found to breed true to the unusually small size. Lastly, among the birds of intermediate size there should be some which are pure for 2 factors, *e.g.*, *AABBccdd*, which should breed true to a size intermediate between that of the Hamburgh and the Sebright. Recent tests have revealed the existence of such birds.

This series of experiments suggests that even so complicated

* "On Inheritance of Weight in Poultry," by R. C. Punnett and P. G. Bailey: *Journal of Genetics*, Vol. IV, 1914.

a character as that of weight, where inheritance is seemingly of a blended nature, can nevertheless be interpreted in terms of definite factors, each producing a definite effect. It is not of course suggested that weight is dependent solely upon such factors. Absolute uniformity, even where animals are of the same genetical constitution, cannot be expected. For no two animals can be treated exactly alike with respect to food and other conditions. Moreover, it is conceivable that other factors, influencing vigour as distinct from weight, may come into operation, and produce some effect upon weight itself.

The results are not without interest in connection with the problems of in-breeding and the effects of a cross. Close in-breeding is held by some to lead to deterioration in the matter of size, and there is certainly some foundation for this belief. Yet it is by no means certain that, sometimes at any rate, this deterioration is not due to the fact that the original material was impure in some of the size factors, and that one or more of these may have been eliminated by unconscious selection. Again, there is much evidence to suggest the view that first-cross animals frequently make unusually good growth, and exceed both parental strains in weight. By some this effect is referred to the increased vigour resulting from a cross. This, of course, is no explanation, so long as we cannot state precisely how this increased vigour is brought about. It may be that there are definite factors working for vigour, though at present this has not been experimentally proved. The poultry results force us to recognise that increased size in first crosses may be due to a cumulative effect of different size factors brought in by the two parental breeds.

The two strains *AABBccdd* and *aabbCCDD* would each be of intermediate size, and nearer in this respect to the Sebright than to the Hamburgh. First-cross birds betewen these two would be in constitution *AaBbCcDd*, *i.e.*, of the same constitution as the F1 Hamburgh-Sebrights. They would be larger than either of the intermediate parental strains, but this increase would not be due to vigour incidental to a cross, but to the cumulative effect of the 4 factors *A*, *B*, *C*, *D*, of which two were brought into the cross by each parent. Moreover, such F1 birds might be expected to give a small proportion of progeny larger than themselves, and breeding true to this increase in size. Where a notable increase in size follows on a cross, it suggests that the breeds used contained different size factors; and if this were so it would be possible to establish a strain of increased size by working on the lines indicated by the factorial theory.

Suggestive as the poultry experiments are, we recognise that we are only at the beginning of this kind of enquiry. Some experiments of a similar nature with rabbits gave a different result.* A cross was made between the Polish, which is the smallest of the breeds of domesticated rabbits, and the Flemish, which is one of the largest. The Polish was used as the father of the F1 animals, which were intermediate, and fairly uniform in size (Fig. 7). From two pairs of such F1 animals an F2 generation was raised. Owing to lack of accommodation the total number of offspring reared was only 37. Nevertheless this F2 generation shows a remarkable feature in that the size of the F1 animals was not exceeded, although some were nearly as small as the Polish parent. The absence from the F2 generation of anything approaching the size of the Flemish is highly puzzling, and no explanation can at present be offered. The experiment is being repeated with the difference that the F1 animals have been bred from Polish doe × Flemish buck, instead of in the reverse way as before.

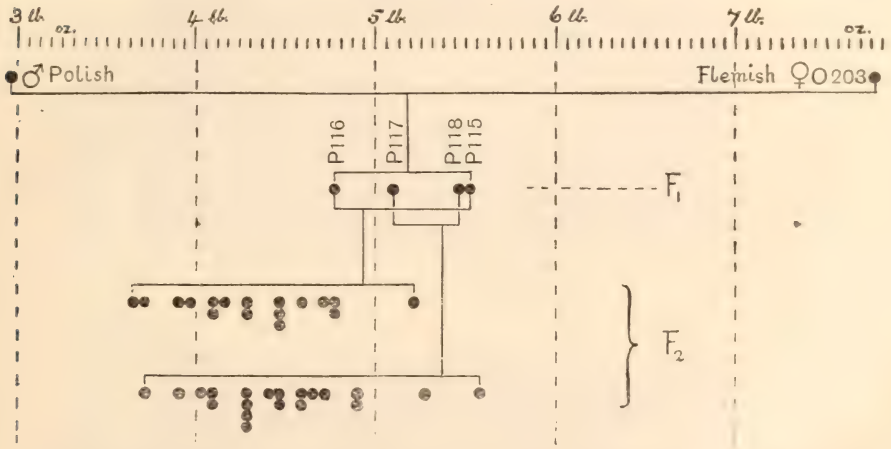

FIG. 7. Illustrating the inheritance of weight in a Polish × Flemish cross. Each individual is represented by a dot on the chart according to its weight in lb. and oz. Thus, the F_1 animal, P116 weighs 4 lb. 13 oz., and the P117 weighs 5 lb. 2 oz.

When planning investigations on these cases of apparently continuous variations it was felt desirable to choose another example of a different type. Accordingly a "pattern" case was selected in rabbits. Here, as in many of the domesticated animals, we encounter white markings, and the extent of these is very variable. We can in fact obtain a continuous series

* "Genetic Studies in Rabbits. 1.—On the Inheritance of Weight," by R. C. Punnett and the late P. G. Bailey: *Journal of Genetics*, Vol. VIII, 1918–19.

in the rabbit, ranging between the self-coloured animal with a touch of white on the nose or on a paw, and an animal completely white except for a touch of pigment round the eye and at the root of the tail (Plate 2, Fig. 3). Such a continuous series can in fact be bred in the F2 generation from a cross between a self-coloured animal and one of these almost white ones. The problem here again was to determine whether such an apparently continuous series could be expressed in terms of a few definite factors, or whether some other explanation had to be sought.

The case was of more than usual interest because Professor Castle, working at a similar case in rats, had put forward the view that the factor itself could be changed by "selection." Were this view upheld by experimental research, it is evident that we should have to give up the conception of the relative permanence of the factor which forms the basis of the factorial theory, and with it that hope of control over breeding operations which the definite and permanent factor signifies. The results of our experiments with rabbits did not bear out Professor Castle's view. We found that a comparatively simple interpretation on factorial lines would cover the facts.* Moreover, Professor Castle himself has recently given up his earlier view, and considers that an orthodox explanation, in terms of the factorial theory, is adequate. We have mentioned the case here because the idea that the factor can be influenced by "selection" is to be found in text-books that are widely read. It may serve to prevent misunderstanding if it is realised that the view is no longer supported by its originator.

As we have already stated, a cross between a self-coloured animal and a "White Dutch" gives F1 animals with a small but varying amount of white, and in F2 a full range from Self to White Dutch. In such a series, however, the gradual increase of the White occurs in a more or less orderly fashion. It begins with the tip of the nose or muzzle, the tips of the fore paws, and the "blaze"; it then invades the neck, shoulders and fore limbs; at a more advanced stage we reach the typical pattern of the Dutch rabbit (Plate 2, Fig. 1); later on the pigmented area round the eyes is reduced and the coloured area of the body becomes patched with white, giving rise to the "spotted Dutch" (Plate 2, Fig. 2); further reduction of the pigment eventually results in the White Dutch (Plate 2, Fig. 3).

* "The Genetics of the Dutch Rabbit—a Criticism," by R. C. Punnett: *Journal of Genetics*, Vol. IX, 1920.

FIG. 1.—Rabbit with Dutch pattern

FIG. 2.—Spotted Dutch rabbit

FIG. 3.—White Dutch rabbit.

A long series of experiments has shown us that 3 pattern-types corresponding to Dutch, spotted Dutch, and White Dutch can be got to breed approximately true. The more pigmented tends to be dominant to the less pigmented, but as a rule dominance is far from complete, so that various intermediate forms arise. Two pairs of factors *T*-*t* and *S*-*s* serve to interpret the range of forms between Dutch and White Dutch, Dutch being *TTSS*, Spotted Dutch *ttSS*, and White Dutch *ttss*.

The relation of all these to the more heavily pigmented grades is determined by another factor *P*; its presence represents much increased pigmentation. A single dose of *P* added to White Dutch transforms the animal into one with a pattern resembling the Dutch*; added to Spotted Dutch, it leads to a grade of pigmentation between Dutch and self-colour; added to Dutch, it results in an animal that is almost or quite self-coloured. Where the animal is *PP* the White area is further diminished, but the difference between *PP* and *Pp* animals has not yet been fully worked out.

The outstanding fact in connection with these patterns is that analysis of this continuous series, from self to almost white, has provided an interpretation in terms of the factorial theory; and that, too, in terms of but 3 factors.

* The *Ppttss* animal may be indistinguishable from the *ppTTSS* animal in appearance, but the two breed very differently.

HOP-"MOULD" AND ITS CONTROL.

II.

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The first part of this article, published in the May issue of the JOURNAL, *contained a description of the Life-History of the Hop-"Mould" or Mildew. An account was given of the damage caused by "Mould" and the preventive measures to be taken against further attacks. The figure numbers quoted below refer to the illustrations in Part I.*

Indirect Methods.—It is of great importance for the hop-grower who experiences trouble with "mould" to pay attention to the following indirect methods of keeping the disease in check.

(1) *Destruction of "mouldy" Hops and Bines.*—The dangerous practice is sometimes followed, even by experienced hop-growers, of not picking the hops in a garden, or in a portion of it, which has become overrun by "mould." Such "mouldy" hops are often left on the poles or wirework for weeks after hop-picking-time (*Fig. 10*) for the linnets to shatter or for the wind to blow away. The result is that the "petals" of these over-ripe hops, bearing thousands of conceptacles with winter-spores (*Fig. 6*), become dispersed over the surface of the hop-garden, with the result that next season, given suitable weather conditions, severe attacks of "mould" occur again in the same garden. It is difficult to believe that any hop-grower becoming conversant with the life-history of the hop-mildew would tolerate this practice of sowing his hop-garden with the "seeds" (spores) of "mould." Even in the stress of hop-picking time, or at any rate immediately afterwards and before the unpicked hops have become shattered, the bine and the mouldy hops should be collected and burnt on the spot or carted off to make a bonfire on ground outside the hop-garden. Mouldy bines and hops should not be used as litter in yards where the dung is carted out to hop-gardens, nor as foundation for stacks except in places far removed from hop-gardens.

(2) *Early "Stripping" and Removal of "Runners."*—Where there is reason to fear an early outbreak of "mould" through

contamination of the soil, it is a wise precaution (in addition to early sulphuring) to strip off the lowermost leaves of the bine as early as it is safe to do so. The lower leaves of the bine serve as rungs of a ladder by which the " mould " ascends higher and higher towards the " burr." The lowermost leaves can be removed first and then in one or two operations at a later date the remaining leaves up to the " breast-wire " or about five feet; by this plan the growth of the young hop-plant does not receive too great a check.

The spread of the disease later in the season is frequently caused by the patches of " mould " present on the leaves of the " runners " growing out of the hills. The summer-spores from these patches are carried by the wind to the young hops where they give rise to " mould " or " red mould." The " runners " should be cut off with the hoe, or—a better practice —pulled out of the " hill." For the same reason any lateral shoots from the stripped bine should be removed.

(3) *Avoidance of " Housing-in."*—With certain systems of planting and training a great deal of bine is produced which gets matted together at the top, the " heads " extending more or less across the alleys—a condition known as " housed-in." In these circumstances there is a lack of ventilation and sunshine, and " mould " thrives. A system of training should be adopted to remedy these drawbacks.*

(4) *Balanced Manuring.*—Excess of nitrogenous manure induces late sappy growth of the hop-plant, which is then specially liable to be overrun by " mould." The necessary phosphatic and potash requirements of the crop must not be neglected.*

(5) *Provision of Male Hops.*—The planting of male hops (1 male hill to every 200 female hills) throughout the garden provides for the fertilisation of the " brush," and thus appreciably shortens the critical period when the hop is in " burr." The male hop must be of a variety which produces pollen-dust at the time when the particular variety with which it is planted is in " burr." The seeded portion of a hop-cone is less liable to " mould " than the seedless part—a fact first pointed out by Mr. A. Howard when at Wye College.†

(6) *Extirpation of " Wild Hops " in Hedges and Waste Places.* —Where so-called " wild hops " (usually originating as " cuts " thrown out from a hop-garden) exist in the neigh-

* See *A. Amos*, Hop Cultivation (*Journ. Board of Agric.*), XVI, 881 (1910).

† See *Journ S.E. Agric. Coll.*, XIV, 214 (1905).

bourhood of a hop-garden, they constitute a source of danger. As soon as "mould" occurs on these "wild hops"—which is often very early in the season—myriads of summer-spores begin to stream from them on the air, and with favouring winds these reach adjacent hop-gardens. Since "wild hops" are not sulphured, the "mould" on them constitutes an unchecked source of infection throughout the season; the soil beneath them becomes plentifully contaminated with the conceptacles and their winter-spores, accounting for the early outbreaks of "mould" which so often occur year after year on "wild hops." A case of the sudden infection early in the season of a hop-garden at "Spring Grove," Wye, was investigated by Mr. Arthur Amos and the writer. The original source of the outbreak was tracked down to some "mouldy" "wild hops'" growing by the side of a ditch adjoining the hop-garden. Infection of the hop-garden from this point was proceeding through a wedge-shaped area of increasing dimensions. All "wild hops" in the vicinity of a garden should be grubbed up and destroyed.*

(7) *Varieties Resistant to "Mould."*—No exact testing, under the same conditions, of the comparative susceptibility to "mould" of the various commercial varieties of hops appears to have been made. The true "Golding" varieties are generally believed to be specially susceptible, while the old varieties "Grapes" and "Jones" have been stated to be more resistant. It is probable that under certain conditions all the commercial varieties of hops at present grown are liable to bad attacks of "mould." There is, however, one variety of hop which is absolutely immune to the attacks of "mould." This is a variety which possesses yellow-green leaves and is called the "Golden Hop"; it is sold by nurserymen as a garden plant, and does not appear to have any commercial value, since it is of weak growth and the hops are of poor brewing quality. Attempts are being made at Wye College to raise, by "cross-breeding" from the "Golden Hop," seedlings immune to "mould" and possessing the other desirable characteristics.

* The same species of mildew (*S. Humuli*) lives on the cultivated Strawberry and also on a number of common weeds (*e.g.*, Meadow-sweet, Field Lady's-mantle, Willow-herb, *Potentilla reptans*). Investigations have shown, however, that the forms of the mildew on all these plants are *specialised* and cannot pass, *e.g.*, from the hop-plant to the strawberry, or vice versâ. (See *E. S. Salmon* in Journ. Agric. Sci., II, 327 (1907). There is consequently no danger to the hop-garden from this mildew growing on any other plants—notwithstanding the statement to the contrary that is occasionally met with.

Spurious Measures often taken against " Mould."—(1) *Sulphur in the " Hill."*—In the mistaken belief that " mould " lives on the hop-plant in the " hill " during the winter months, applications of sulphur (usually in the form of " black sulphur," *sulphur vivum* or " green sulphur ") are given to the crown of the " hill " in early spring. Since the " spawn " of the hop-mildew does not occur in the " hill " or on the crown, it is mere waste of labour and material to apply sulphur (or any proprietary article) in this manner. Sulphur, and chemical substances generally, are not able to kill the winter-spores in the conceptacles, which may be lying on or in the soil around the " hill," owing to the thick, impervious " corky " walls of the conceptacle.

(2) *Use of Gypsum.*—Although gypsum (sulphate of lime) may under certain conditions act as a fertiliser when applied to the soil and so promote the general growth of the hop-plant, there is no scientific warrant for the belief held by some farmers and fostered by the sellers of gypsum, that the sulphur contained in gypsum is taken up by the plant which then becomes proof against " mould." This theory probably dates from the period when " mould " was generally believed to be due to the diseased condition of the sap of the hop-plant.

The practice of using gypsum in the " hill " (usually at the time of " dressing " or " cutting ") is, for the reasons given above (1), only a waste of labour and material.

NOTES ON MANURES FOR JUNE.

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The Possible Use of Town Refuse as Manure.—The question has often been asked whether town refuse can safely be used as manure, and if so, what price the farmer would be justified in paying for it. Town refuse has the great advantage that it is available at all times and in considerable quantity, and on heavy land it has proved effective in lightening the soil and making it work more easily. It has, however, the great disadvantage that it may contain the germs of crop diseases, and this has become all the more serious since the spread of Wart Disease throughout various counties. Unfortunately no simple test is known to enable one to ascertain whether a bulk of town refuse is or is not free from the spores of wart disease.

Apart from this risk, however, there is a good deal to be said for its use. Its composition varies considerably as between different towns, though in any given town the variation may be less than might be expected. Thus, three separate samples from Sheffield have given the following results:—

Percentage of	*Sample 1.*	*Sample 2.*	*Sample 3.*
Moisture	2·84	2·89	2·77
Organic matter (loss on ignition)	28·6	34·2	37·5
Nitrogen (total)	·7	0·57	0·67
Equal to Ammonia	·86	0·70	0·81
Phosphoric Acid (as P_2O_5)	·77	0·49	0·45
Equal to Tri-basic Phosphate of Lime .	1·74	1·09	0·98
Potash (as K_2O)	·33	0·64	0·50
Lime (as Calcium Carbonate by calcimeter)	4·93	1·6	2·1

There is a satisfactory amount of organic matter and of nitrogen, and the lime, while not large in quantity, would help in lightening a heavy soil.

The Storage of Artificial Manures.—A correspondent has raised the question as to how long various artificial manures may be kept stored in a dry place without losing effectiveness. With the exception of superphosphate most artificial manures could be kept indefinitely if the conditions of storage were sufficiently good. In practical circumstances, however, the conditions are more or less defective, and trouble arises owing to the absorption of moisture.

Basic Slag is very little affected by storage, and can be kept almost indefinitely in a reasonably dry shed or store.

Sulphate of Ammonia is somewhat more easily affected by atmospheric moisture, especially if it comes from small gas works where it has not been well finished. The well-made neutral sulphate, however, is less affected. In any case the material is best stored in bags placed on planks or on a layer of peat rather than on the bare earth or brick floor. It may cake somewhat on storage, and should then be broken up with a wooden crusher.

Nitrate of Soda, Kainit and Sulphate of Potash.—These substances will keep indefinitely under dry conditions, such as the merchant's store; they may also be preserved for a long time in a well built shed on a farm. They undergo no inherent deterioration, but they may become lumpy through the action of moisture, and must then be crushed. There is no practical limit to the length of time the above fertilisers may be kept so long as the conditions are suitable.

Superphosphate is in a rather different category, and undergoes slow change on storage, which up to a certain point is advantageous. Well made samples in good condition have been stored for the necessary time by the makers; but prolonged storage may cause deterioration to set in. On the whole it is advisable to avoid the necessity of storing by careful calculation of the requirements and by using early in the following season any material that happens to be left over.

Nitrate of Lime cannot easily be stored once the package has been opened, as it is liable to absorb moisture in damp situations.

Ground Limestone can be stored indefinitely, either in bags or in bulk; but *lime* cannot be stored in bags, again because of its great power of absorbing moisture.

Nauru Phosphate.—Much interest is being taken in Nauru phosphate, and enquiries are being made by farmers and others as to its probable value. Samples are not yet to hand, but arrangements have been made at Rothamsted for a field test as soon as the material arrives.* Even if it proved unsuitable for direct application to the land, it might still be found valuable in the manufacture of superphosphate. It is stated to be very rich in phosphate, containing phosphoric acid equivalent to 85-86 per cent. of tricalcic phosphate, with occasional patches running as high as 87-88 per cent.; there is said to be no low grade, and that it would be impossible to ship a cargo running below 80 per cent. without deliberate

* Experiments are already being undertaken elsewhere.

adulteration. The original estimate of the amount on the island was 50,000,000 tons, but this figure has now been amplified and is put at 75,000,000 tons. The composition is better than that of African phosphates, which contain phosphoric acid equivalent to about 60 per cent. of tricalcic phosphate. It remains to be seen, however, whether it can compete in the matter of price and effectiveness with these phosphates in view of the long sea voyage: Nauru lies nearly 2,000 miles to the N.E. of Australia, half-way between the Solomon Islands and the Marshall Islands, and freight is bound to be an important consideration.

Potash Content of French Kainit.—The company responsible for the supply of French potash fertilisers informs us that the grade of Sylvinite known as French Kainit is sold with a minimum guarantee of 14 per cent. of potash (K_2O), and that its composition actually approximates to 14-16 per cent. This correction is made because a somewhat lower figure was mentioned in an earlier issue of these notes.

NOTES ON FEEDING STUFFS FOR JUNE.

E. T. HALNAN, M.A.,
Ministry of Agriculture and Fisheries.

Hints on the Storage of Cake.—On most farms the stocks of cake bought for winter use will be almost exhausted, and it may therefore be opportune to enumerate the chief points to observe in order to keep cakes in good condition. The corner of the shed used as a cake store should be dry and well ventilated, and if possible should be provided with a cement floor. In buying cakes the purchaser should see that the cakes are dry and in clean wholesome condition. It is generally a good investment to have cakes analysed. Cakes that are at all mouldy or damp should be avoided at all costs. In stacking the cakes, care should be taken to stack them so that the air can circulate freely through the pile, in order to avoid the possibility of damping and overheating. Cakes that are properly stored in a dry, well ventilated shed, keep sweet and wholesome for a long time, and the little extra trouble and expense in providing a suitable shed for well stacking the cakes is more than repaid by the absence of feeding troubles.

Oats and Oat By-products.—Oats are familiar to all farmers as a stock feed and are especially valued for young and growing stock. Oats form a palatable feed for horses, cows, cattle and sheep. For horses, the oats are fed whole or clipped; for cows and cattle and sheep, the oats are roughly crushed. With the hulls removed, and finely ground, oats form an excellent food for young calves and growing pigs. For poultry, the oats are ground whole to a fine impalpable meal, which under the name of Sussex ground oats is especially valued for fattening poultry.

In the manufacture of oatmeal for human consumption several by-products arise which are, perhaps, less familiar to the stock feeder. The outside hull is first removed. The hulls resemble chaff in composition, and have a very low feeding value, but can be regarded as a suitable diluent for concentrated feeding stuffs. The hulls, called "sids" in Scotland, form from 20-40 per cent. by weight of the whole grain, and hundreds of tons are produced annually and find a ready market. In Scotland it is the usual practice for the miller

NAME.	Price per Qr. s.	lb.	Price per Ton. £ s.	Manurial Value per Ton. £ s.	Food Value per Ton. £ s.	Starch Equiv. per 100 lb.	Price per Unit, Starch Equiv. s.	Price per lb. Starch Equiv. d.
Barley, English Feeding	42/-	400	11 15	1 6	10 9	71	2/11	1·56
„ Canadian „	40/-	400	11 4	1 6	9 18	71	2/9	1·47
Oats, English „	44/-	336	14 13	1 9	13 4	59·5	4/5	2·37
„ Foreign „	32/-	320	11 4	1 9	9 15	59·5	3/3	1·74
Maize, Argentine	52/6	480	12 5	1 5	11 0	81	2/9	1·47
Beans, English spring	70/-	532	14 15	3 1	11 14	66	3/6	1·87
„ „ winter	55/-	532	11 12	3 1	8 11	66	2/7	1·38
„ Rangoon	8/6	112	8 10	3 1	5 9	66	1/8	0·89
Peas, English blue	58/-	504	12 18	2 13	10 5	69	3/-	1·61
„ „ dun	70/-	504	15 11	2 13	12 18	69	3/9	2·01
„ „ maple	72/-	504	16 0	2 13	13 7	69	3/10	2·05
„ Japanese*	112/6	504	25 0	2 13	22 7	69	6/6	3·48
Buckwheat	64/-	392	18 6	1 9	16 17	53	6/4	3·39
Rye, English	55/3	480	12 18	1 8	11 10	72	3/2	1·70
Millers' offals—Bran	—	—	6 15	2 10	4 5	45	1/11	1·03
„ „ Coarse middlings	—	—	9 5	2 10	6 15	64	2/1	1·12
Barley meal	—	—	15 0	1 6	13 14	71	3/10	2·05
Maize „	—	—	10 17	1 5	9 12	81	2/4	1·25
Fish „	—	—	21 0	7 12	13 8	53	5/1	2·72
Linseed Cake, English	—	—	16 7	3 12	12 15	74	3/5	1·83
Cotton seed „ „	—	—	12 10	3 5	9 5	42	4/5	2·37
„ „ decorticated	—	—	15 0	5 6	9 14	71	2/9	1·47
„ Meal decorticated	—	—	12 15	5 6	7 9	71	2/1	1·12
Coconut cake	—	—	10 0	3 0	7 0	79	1/9	0·94
Groundnut cake	—	—	9 0	3 9	5 11	57	1/11	1·03
„ „ decorticated	—	—	12 0	5 5	6 15	73	1/10	0·98
Palm kernel cake	—	—	6 5	2 1	4 4	75	1/1	0·58
Brewers' grains, dried, ale	—	—	6 17	2 7	4 10	49	1/10	0·98
„ „ wet „	—	—	1 7	0 12	0 15	15	1/-	0·54
Distillers' „ dry	—	—	11 0	2 16	8 4	57	2/11	1·56
Malt culms	—	—	7 0	3 6	3 14	43	1/9	0·94
Potatoes†	—	—	2 17	0 8	2 9	18	2/9	1·47
Swedes†	—	—	1 4	0 5	0 19	7	2/9	1·47
Mangolds†	—	—	1 3	0 6	0 17	6	2/9	1·47
Vetch and oat silage†	—	—	2 13	0 15	1 18	14	2/9	1·47

* Price at Liverpool. † Farm value.

NOTE.—The prices quoted above represent the average prices at which actual wholesale transactions have taken place in London, unless otherwise stated, and refer to the price ex mill or store. The prices were current at the end of April and are, as a rule, considerably lower than the prices at local country markets, the difference being due to carriage and dealers' commission. Buyers can, however, easily compare the relative prices of the feeding stuffs on offer at their local market by the method of calculation used in these notes. Thus, suppose palm kernel cake is offered locally at £10 per ton. Its manurial value is £2 1s. per ton. The food value per ton is therefore £7 19s. per ton. Dividing this figure by 75, the starch equivalent of palm kernel cake as given in the table, the cost per unit of starch equivalent is 2s. 1d. Dividing this again by 22·4, the number of pounds of starch equivalent in 1 unit, the cost per lb. of starch equivalent is 1·11d. A similar calculation will show the relative cost per lb. of starch equivalent of other feeding stuffs on the same local market. From the results of such calculations a buyer can determine which feeding stuff gives him the best value at the prices quoted on his own market.

to send the " sids " back to the farmers who sent in the oats for milling.

After the hulls have been removed, the resultant kernel is further treated to remove the tuft of hairs present at the top, and these hairs form the product called " oat dust." This oat dust forms a light fluffy felted mass, contains a considerable proportion of protein and fat, and owing to its nature is usually sold mixed with other feeding stuffs.

In further treatment the outside skins of the kernels are partially or wholly removed, and this product forms the oat bran, middlings, or shorts. Oat bran resembles wheat bran in composition and feeding value, but contains more fat.

The appended table of chemical analyses taken from Henry's Feeds and Feeding will give the reader an idea of the comparative values of the oat and its by-products.

	Water.	Protein.	Fibre.	Nitrogen-free Extract.	Fat.	Ash.
Oats ...	9·2	12·4	10·9	59·6	4·4	3·5
Oat bran ...	6·4	12·2	18·3	52·3	4·7	6·1
Oat dust ...	6·6	12·6	18·7	49·9	5·2	7·0
Oat hulls ...	6·8	4·0	29·2	52·3	1·7	6·0

Notes on Table of Prices.—Palm kernel cake and wet brewers' grains form two very cheap feeding stuffs. There is little doubt that the cheapness of palm kernel cake is associated with the fact that it is a difficult cake to get the stock to eat *at first*. The golden rule with palm kernel cake is to introduce it very gradually into the feed and to keep the troughs scrupulously clean.

AGRICULTURE ABROAD.

AGRICULTURAL SCHOOLS IN ALBERTA—WHEAT GROWING IN CANADA.

THE following note has been communicated by Mr. J. McCaig, Editor of Publications, Department of Agriculture, Alberta :—

System of Middle Agricultural Schools in Alberta.

The Province of Alberta, Canada, is becoming distinguished for its work in agricultural education, chiefly through the influence and work of the Hon. Duncan Marshall, present Minister of Agriculture for the Province. Mr. Marshall is a frequent visitor to the Mother Country and may be known to a good many readers of this *Journal*. In company with two other Canadian breeders he recently purchased a shipment of Shorthorns and Shropshires for his own farm.

Contrary to common practice, the Alberta system of agricultural education begins with a strong understructure rather than a heavy top, as represented by an agricultural college. All the provinces of Canada, in fact, are active in utilising a good body of agricultural material in connection with the elementary schools. This body is commonly referred to as " educational agriculture " rather than " material for agricultural education." A good deal has been accomplished in this elementary work in Alberta.

Both Boys and Girls.—Mr. Marshall's efforts relate specifically to the farm boys and girls after they have passed the elementary school age. The agricultural schools are administered by the Department of Agriculture, not by the Department of Education, and this gives them perhaps a closer touch with practice and application than they could possibly have as part of the general scholastic system. The schools are not integrated with the general educational system, but the work done in the agricultural schools, if students have sufficient general training for matriculation, counts in their university course at the college of agriculture. The outstanding service of the schools is that they give direct training to boys and girls who intend to go back to the farm. At present there are six of these schools in the Province, one-half of them having been opened in the autumn of 1920. It is expected that they will train upwards of one thousand boys and girls during the year. One of the schools during the last two years has done good work in training returned soldiers. The Minister has expressed his intention of making provision at these schools for special courses for British boys

and girls who need to be taught something about western agriculture before going on the land. These would probably be summer courses and would include a combination of study and farm work.

Free Courses.—Pupils must be sixteen years of age: there are no academic restrictions and no fees for tuition. The course extends over two years and sessions are limited to the period between October and April. Courses for boys, and for girls likewise if they wish to take them, include field husbandry, animal husbandry, dairying, shopwork and machinery, horticulture, poultry keeping, farm management, elementary farm economics, English, and farm mathematics. The sciences underlying these subjects are part of instruction so far as they relate directly to practice. The schools have a number of improving organisations such as athletic, musical and literary clubs.

Classes for girls include cooking, sewing, nursing, household management, accounting, dairying, poultry keeping and horticulture. They have instruction in the direct sciences such as bacteriology, chemistry, physics, &c., relating to practice. They also have English and mathematics and share in the benefit from the organisations for improvement and recreation. There are about six or seven teachers on the staff of each school.

Institutional Farms.—Connected with each school is an institutional farm called a demonstration farm. It is generally of a good size, consisting of not less than 320 acres, of which thirty acres are devoted to experimental work. The rest of the land is run like an ordinary farm with a manager and hired men, but it is under the direction of the head of the school for the purpose of ensuring that it shall exemplify farm practice of a high grade, based on the findings of the school. A good deal of attention is devoted to establishing conserving rotations, but this is not easy on parts of the prairie where grain growing is the chief business. The farms also serve for the raising of good seed and live stock, which are distributed to farmers at reasonable prices.

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Wheat Growing in Canada.

FURTHER interesting particulars of the efforts made to improve the crop and increase the acreage of wheat in Canada are given in *The Agricultural Gazette for Canada* for May last. The April issue of this JOURNAL contained some information regarding the work of the Federal Government, assisted by private individuals who specialised in wheat growing. The following

gives an outline of the important part performed by the Provincial Departments of Agriculture during the War period and after. Three wheat growing Provinces are taken, which will suffice to show the trend of the great efforts which were carried on throughout the Dominion.

New Brunswick.—In 1917 and 1918 larger quantities of seed than ever before were imported, and correspondingly larger crops were harvested. In 1917, the acreage sown to wheat was about 15,000 acres; in 1918 it had trebled. The Provincial Government gave financial assistance in the erection of roller process mills, of which there are now 34 in the Province. Although a humid climate is generally unfavourable to wheat growing, large yields of excellent quality were recorded. Last season, in Kent County, a yield of 225 bushels of the White Fife variety was harvested from four acres—an average of 56 bushels per acre.

Ontario.—One million acres is the usual area sown to wheat in Ontario, which is well adapted for the production of high-yielding varieties of white winter wheat. In 1917 many car loads of Marquis spring wheat were imported from New York State for seed. Experiments in the testing and selection of seeds are made at the Ontario Agricultural College, and the results are published in bulletins, circulars and newspaper articles. Dawson's Golden Chaff is the most extensively grown variety of winter wheat in Ontario. Originating in the Province thirty-nine years ago, it produces a very stiff straw of medium length; it has beardless heads with red chaff and white grain, and is a heavy yielder, but the grain is rather soft. With the object of originating better varieties, crosses have been made at the College between high-quality varieties. One of these, Dawson's Golden Chaff, crossed with Bulgarian, has furnished a new variety called O.A.C. No. 104, which has given excellent results throughout Ontario. Several varieties of winter wheat are distributed each year for co-operative experiments.

Manitoba.—Wheat improvement in this Province commenced at the Manitoba Agricultural College in 1916; it is therefore too soon to expect striking results. The objects are twofold: (1) to obtain strains of wheat that will retain the high milling qualities of Marquis and Red Fife and will also yield well under the varied conditions prevailing in the Province; (2) to propagate pure lines selections and so become a source of elite stock seed. Introductions have been made from Denmark,

Sweden, New Zealand, Australia and the United States, and promising strains have already been secured, and these will be tested out. While many of them will probably not be of sufficient merit to be grown on the farms, they will be of great value for breeding. In 1916, about 250 selections were made from common varieties. Of these, one from Red Fife and two from Marquis have shown superior qualities and are being propagated. Pure line strains of approved varieties will be increased on the College farm; the seed will be sold by the Field Husbandry Department to seed growers and the provincial demonstration farms, and the crop inspected in the field by a representative of the Department. When thrashed, it will be re-purchased by the Department at a stated premium over market wheat and will then be cleaned and sold to one or two growers in each agricultural society. The grain will be again inspected in the field, and the seed cleaned through one of the local cleaning plants and sold to farmers in that locality through the Agricultural Society. Under this scheme, superior seed will be available in every part of the Province in less than five years. The activities of the Agricultural Societies include ploughing matches, standing field crop competitions, and seed grain fairs.

The following note has been communicated by Mr. W. A. Watts, Bryn, St. Asaph, N. Wales :—

Egg Collecting and Mat Making in Anglesey.

Egg Collecting.—Among the enterprises fostered by the Anglesey Branch of the Welsh Industries Association is an egg collecting depot. The depot building was erected by the L. & N.W. Railway Company at Llanfair P.G. station. Beginning on a small scale, the scheme developed steadily year by year until, in 1920, the turnover reached nearly £36,000, while the number of eggs collected amounted to over two and a quarter millions. During the busy season, as many as 95,000 eggs a week are collected by the Society's four motor vans which tour the island and parts of Carnarvonshire, collecting from each member at least once a week. At the depot the eggs are carefully tested and graded by girls who, after long practice, have become experts in this work, and so thoroughly is the work done that Anglesey eggs have gained a high reputation, the demand at the best prices being always in excess of the supply. Run on co-operative lines the Anglesey Egg Collecting Depot, Limited, as the Society is styled, now has 650 members. Everything possible is done to encourage egg production: for six months of last year an expert engaged by the Society travelled round the whole district, visiting and giving advice to all the members.

Mat Making.—Another instance of a successful rural enterprise is that of mat making, conducted at Newborough. The ancient industry of mat making has been carried on at Newborough, a village close to the sea, for many years, the material used being Marram grass,* which grows on the sand dunes near by. The grass is cut in August or September and is stacked ready for use. Originally made for thatching stacks, few mats were sent out of the neighbourhood and buyers could obtain them only from local tradesmen, who received them from the actual makers in return for groceries, bread and other necessaries, not for cash. The rope made from the same material, however, found a wider market, being used in railway works and slate quarries.

During the War the industry was taken in hand by the Anglesey Branch of the Welsh Industries Association. It was believed that when the importation of Archangel mats ceased, there was a possibility of placing the Newborough product on the market and so establishing a new trade for horticultural purposes. Several of the leading nurserymen commendably agreed to try

* See this *Journal*, February, 1914, p. 996, and February, 1913, p. 935.

the mats and so encourage a home industry. They found the mats successful, and ordered large quantities; the demand from other directions increased rapidly and the makers realised higher prices.

For thatching purposes, the mats were originally made 15 ft. by 4 ft., but for horticultural purposes they are chiefly made 12 ft. by 4 ft. They are almost frost proof and very durable, and will last five years or more. In 1918, a meeting of members, who, it should be noted are all women, was held, when it was decided to form and register a Co-operative Society, the Newborough Mat Makers' Association, affiliated to the Agricultural Organisation Society. The shares are of the value of 2s. 6d. each, fully paid.

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The Suppression of Weeds: National Necessity.

THE suppression of weeds, always an important consideration to farmers, is specially urgent at the persent time. During the War, shortage of labour and the increase of the area under corn and root crops led to the rapid fouling of land formerly clean, and the result of these conditions is still apparent. Farmers are urged, therefore, to remit no effort in combating weeds, which cause so serious a reduction in crop yields. If existing arable land is to be kept in a high state of cultivation, it is essential to sow pure seed of high germinating power and to keep weeds down. Suppression of weeds is also a main factor in the improvement of pasture.

Weeds are injurious in many ways. They absorb moisture and plant food which should go to benefit the crops; they crowd the good growths, checking the free circulation of air; they deprive the sprouting seed of necessary sunlight; they hamper harvesting operations and interfere with the singling of roots. Further, these enemies of good husbandry harbour insect pests, reduce the value both of hay and of cereal samples and, where they are parasitic or semi-parasitic, obtain their food by direct robbery of the crops they infest. Nor does this exhaust all counts of the indictment. Some weeds, such as garlic, taint the milk of cows. Drains may be stopped by the underground spread of weed-stems and roots.

The advantages of thorough weeding have been proved by experiment. It has been shown that a properly weeded area of arable land may produce double the crop possible on neglected ground. Land hoed twice produced 37¼ tons of mangolds per

acre but only $16\frac{1}{4}$ tons when weeding after singling was omitted. During the War weeds and the effort to get rid of them cost British farmers millions of pounds.

The war against weeds can be waged successfully only by those who understand the ways in which these pests gain access to the farm land and spread among cultivated crops. Many weed seeds, such as the thistle and dandelion, are carried considerable distances by the wind. Weeds are conveyed also by farmyard manure. They are found in screenings from threshing and winnowing machines, and the sweepings of barns and haylofts. They are found in manure from cattle fed on inferior hay. Well-rotted farmyard manure will contain fewer germinable weed seeds than fresh manure, and is therefore less liable to introduce weeds to clean fields. A potent means of conveyance is the use of poor seed. The presence of 1 per cent. of dock seed in a mixture of grass and clover means 10 or more dock seeds per square acre all over the field on which such a sample is sown at the ordinary rate for leys. Broken pieces of root also serve to spread trouble, and machines, such as self-binders and travelling thrashers, are often responsible for a wide distribution of weed seeds which are carried on the machines and also in the mud picked up by the wheels. The fruits and seeds of certain weeds such as burdock, corn-buttercup, wild carrot and cleavers fasten on the wool and hair of animals and the clothes of human beings and are thus carried considerable distances. Birds also are effective agents in distributing weed seeds.

The most obvious means of suppressing weeds is to prevent seeding. When it is recognised that mature charlock plants produce from 1,000 to 4,000 seeds, a moderate sized poppy 10,000 to 15,000, and large plants often 50,000 seeds, the force of the adage "one year's seeding is 7 years' weeding" becomes manifest. Further, as many weeds produce seeds which do not all germinate at the same time the mischief is greater than appears at first sight, for some may lie dormant in the soil and spring up after an interval of several years. To destroy weeds of this type it is advantageous to introduce into the rotation root and other crops which promote a thorough cleaning. Seeding of weeds in hedgerows, on roadsides, waste places and round farm buildings should be prevented as far as possible. Another important precaution is to avoid the use of imperfectly cleaned seed. The Ministry desires to impress upon farmers the great importance of ensuring that there shall be no failure of crops due to the sowing of poor seed.

Care should be taken to burn such refuse as proceeds from screenings, sweepings of haylofts and the like. Deep ploughing is another very successful method of repression, as many seed- and weeds rot when deeply buried. Harrow cultivation and the preparation of a good tilth before sowing will encourage weed seeds to germinate and the seedlings may be destroyed by further stirring of the soil. Many annual and biennial weeds will thus be cleared away. The use of the horse-hoe is very serviceable for cleaning spring-sown corn. Land on which weeds are plentiful should be disced or lightly scarified immediately after harvest. This will encourage annuals to sprout and the young weeds can be ploughed in afterwards. Hand pulling, digging with fork or spade and the total removal of weeds are efficient but expensive methods, and should be resorted to only when other plans have failed or are inapplicable. In every case the weeds collected should be burned. Fallowing, either bastard or bare, as a cleaning process, is largely practised in heavy soils with good results. On sour, damp soil, liming and draining will prove effective. Sheep's sorrel, corn marigold, spurrey and some other weeds can be checked to a considerable extent by a dressing of lime. Heavy smother crops may also effect a good reduction; on foul land such crops may prove very valuable before roots. Suitable crops for the purpose are mixtures of vetches or peas with oats, or rye with a few beans. In every system of arable farming the growth of a root crop is the most important means of suppressing weeds of all kinds. As a rule, the state of a farmer's root crop towards the end of summer is a good indication of the level of his farming.

No one need unknowingly purchase seeds badly contaminated with such injurious weed seeds as Docks or Sorrels, the Cranesbills, Wild Carrot, Yorkshire fog, or Soft Brome grass, as under the Testing of Seeds Order, 1918, the seller is bound to disclose the presence of these in a parcel of seed if they are present to the extent of more than 1 per cent.

It may also be added that Section 4 (10) of the Agriculture Act, 1920, enables notices to be served on the occupier of any land on which injurious weeds are growing, requiring the occupier to destroy such weeds. Regulations have been laid before Parliament and will be made shortly, enabling these powers to be exercised in respect of land infested with Thistles, Docks or Ragwort.

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The Frit Fly: A Danger to Cereal Crops.

THE Frit Fly is a serious menace to cereal crops throughout the whole of the Northern and Central Europe and the British Isles. In England the severity of the attack varies from year to year. In bad years the whole of the country, except perhaps the Fen Districts, is seriously affected; in other years local damage may occur anywhere. The greatest damage is done to spring-sown oats, but winter oats, winter and spring-sown wheat, barley and rye have been attacked and possibly have suffered more injury than is usually recognised.

The damage to spring-sown oats becomes apparent in late spring and early summer. The main shoot and possibly the first formed tillers cease to grow, the young central shoot dies, but the outer sheathing leaves may remain green. Further tillers form, but perhaps too late to produce ears. A fresh attack occurs in July; in this case the ears are damaged and while the larvæ may be found living on the young soft corn, which they either destroy or so damage as to render it worthless. It is true that this attack is often overlooked, as the effect on the field is not very apparent. The chief indication of the damage is the very light weight of the crop on thrashing. Should the grain be threshed at harvest time, the cause of the light weight may become further apparent from the great number of flies that will issue from the store. A crop may be ruined by the first and at least badly damaged by the second attack.

Frit and eel-worm may occur together, but a frit attack is often confused with that of the eel-worm and recorded under that name. Perhaps the best superficial characteristics by which an eel-worm attack may be determined are the swollen base of the plant and the absence of the white frit grub. Growers, however, are advised not to rely upon their own diagnosis, but to consult an expert. The researches of Petherbridge at Cambridge seem to show that the attack on winter wheat occurs almost solely when this crop follows late ploughed leys—notably of rye grass. This attack may be avoided by bastard fallowing.

Frit-like larvæ—whether the pest of the cereal or of some allied species is not clear—have been found on annual meadow grass, smooth meadow grass, couch grass, perennial rye grass, Italian rye grass, Timothy, meadow foxtail, wood millet, meadow fescue, yellow oat grass, common oat grass, and its

variety onion couch or knot grass. It is therefore probable that on most farms there must always be a large natural reservoir of flies.

In the late summer or autumn the female Frit fly lays her eggs on the leaves or stems of grass, and possibly, though there is little evidence of this, on winter wheat and winter oats. The eggs hatch quickly and the young larvæ make their way to the centre of the shoot, which they destroy. As a rule, throughout the winter, the minute white grub may be found, close down to the base of the shoot; it is about $\frac{1}{8}$th inch in length and without legs. In the spring the grub changes to a pupa inside a reddish brown pupa-case or puparium, either at the point where it has been feeding or at various heights under the outer leaf sheaths. The date of emergence of the frit fly pupa is governed largely by weather conditions. Usually it occurs in England from the middle of April to about the middle of May. The date of the first appearance or at least the period of maximum emergence of the spring brood, is of the utmost importance to farmers, for if the young spring corn is sufficiently advanced in growth at this date, proof exists that it will be immune to attack, at least for all practical purposes. The adult fly is of a brightly shining black, except for the yellowish or brownish legs, and has a characteristic short hopping flight. The female flies, appearing in April or May, lay their eggs on the spring-sown oats and the resulting larvæ pass through similar transformations, doing the same injury to the plant as the previous generation, but the time spent in undergoing these transformations is shorter, lasting from six to eight weeks. During July the flies of the second generation appear, ready to lay their eggs in the ears of the young corn. The third generation appears during August and September, the females laying their eggs on grasses and occasionally perhaps on autumn-sown corn.

To control the pest on oats, the object is to get the young oat plant forward as rapidly as possible. Growth may be accelerated by the use of stimulating manures, which should be readily available. Nitrogenous manures are of most importance. As far as frit fly is concerned, the manure is needed chiefly during the early stages of growth and may even be harmful if used too freely, as it tends to cause lodging. For this reason, therefore, moderate dressings, say $\frac{3}{4}$ to 1 cwt. of sulphate of ammonia along with 2 cwt. of superphosphate per acre, should be applied. Once an attack is far advanced, little can be done in the way of

control: a top-dressing of sulphate of ammonia does not appear to be satisfactory, but nitrate of soda is said to be effective if applied early enough. Winter oats are seldom damaged, and records show that this cereal, sown in the spring, will escape infestation, possibly because it tillers more freely. In any case it must be sown quite early if a crop is to be obtained.

Experiments made to test the resistance of different varieties of oats to frit fly attack, show that there are marked differences but that they are not the same in all parts of the country. In general the more modern varieties do better than the older "Abundance" types, owing to the greater speed with which they throw up the central shoot. On the other hand the old straw-producing oats such as Potato and Sandy, owing to their powers of tillering, recover well from the first attack, though it would seem that they tend to suffer more from the grain attack. Probably the variety best suited to the district will in most cases be found to suffer least from attack, owing to a rapid and healthy growth in the young stages. In this connection the importance of a good seed bed in the case of oats must not be forgotten. Rough, cloddy land tends to retard growth, and in consequence makes the crop very susceptible to frit fly.

Rabies.—Only one outbreak of Rabies has occurred in any part of Great Britain since the last issue of the *Journal*, on the 10th May at Southampton.

Glamorgan District.—All restrictions in connection with the outbreak at Cowbridge on the 11th September last were removed as from the 1st May, 1921.

Metropolitan District.—The position in this District remains unchanged.

Berkshire District.—The District subject to restrictions on account of the outbreaks at Reading and in the High Wycombe District has now been contracted by the exclusion of portions of Hertfordshire, Middlesex, Surrey and Berkshire on the eastern side of the District, and by the exclusion of the District around and to the north of Newbury, on the western side. This modification took effect on the 1st May.

Wilts, Dorset and Hampshire.—A considerable reduction of this area was also made as from the 1st May. With the exception of a small area in the Lambourn District to the south-east of Swindon, which remains under the Muzzling Order, the whole of the northern part of the existing Scheduled District, comprising those portions of Somerset, Wilts, Hampshire and Berkshire which lie approximately north of a line through the towns of Andover, Warminster and Shepton Mallet has been released. At the same time, the requirement of leading has been withdrawn from the Southampton and District Inner Controlled Area.

Foot-and-Mouth Disease.—On the 22nd April a further outbreak of Foot-and-Mouth Disease occurred in Irish animals landed at the Birkenhead Irish Animals Landing Place for slaughter therein ; but no extension of disease has occurred therefrom. The trade in Irish animals was in consequence temporarily suspended.

Yorkshire.—On the 3rd May existence of disease was confirmed in animals at Thurstonland, near Huddersfield. As a result of this outbreak the usual order was issued by the Ministry prohibiting the movement of animals into, out of, along, over, or across any highway or thoroughfare within an area having a radius of approximately 15 miles from the infected premises.

Derbyshire, Norfolk, and Cheshire.—There have been no further developments in connection with the outbreaks confirmed on the 7th March in Derbyshire, the 10th April in Norfolk, and the 16th April in Cheshire. In all three cases the restrictions have been considerably modified and are now applicable only to small areas immediately surrounding the infected premises.

World Supplies of Wheat and Rye.—The Ministry has received the following information from the International Agricultural Institute at Rome :—

It is estimated that the available world supplies of wheat and rye will be sufficient to meet requirements until the next harvest, and to leave a balance on 1st August of at least 6½ million quarters.

Inspection of Tithe Apportionments, &c.—The Minister of Agriculture and Fisheries desires to give notice that as from Tuesday, the 17th May, 1921, the fee for the inspection of Tithe Apportionments, Tithe Maps, &c., at this Office will be increased to 2s. 6d. for each document inspected on each day's attendance.

Past Issues of the *Journal* and *Journal* Supplements.—Readers of this *Journal* whose sets are incomplete may be glad to take advantage of the fact that the Ministry is now in a position to supply copies of most

past issues of the *Journal*, some of which have not recently been available. The copies are in good condition and comprise all issues *except the following* :—

Vol. I, Nos. 1 and 2.	Vol. VI, Nos. 1, 2, 4.
„ II, „ 4.	„ VII, „ 1, 4.
„ III, „ 2.	„ VIII, „ 1, 3.
„ IV, „ 1, 2, 3, 4.	„ IX, „ 3.
„ V, „ 2, 3.	

All who desire to complete their sets are invited to apply for the copies they require, which will be sold at the published price, as follows :—

Vols. I to IV	6d. per single copy (quarterly)	Post free.
„ V to X	1s. „ „ „ „	
„ XI to XXVI (No. 9) ...	4d. „ „ „ (monthly)	
„ XXVI (No. 10) to XXVII	6d. „ „ „ „	

The number of copies of certain issues is very limited.

Copies of *Journal* Supplements are also available, excepting Nos. 4 and 8. A list of these, together with prices, can be obtained on application.

Bound Volumes of Leaflets.—The three Bound Volumes of Leaflets at present issued by the Ministry have been priced at 1s. 6d. per volume. It has recently been decided that the volumes must in future be sold at a price which will approximate more closely to the cost of production, and the Ministry is therefore reluctantly compelled to increase the price to 2s. 6d. per volume, or 6s. the set of three volumes. The volumes can be obtained from the Secretary, Ministry of Agriculture, 10, Whitehall Place, S.W.1.

Guides to Small Holders :—The Ministry still has a good stock of the pamphlets entitled "Guides to Small Holders," which were published in 1919 for distribution chiefly among ex-Service men intending to settle on the land. These guides, which deal with subjects of great interest to farmers, small holders, market gardeners and allotment holders, were formerly priced 2d. each, but were issued free to ex-Service men. They may in future be obtained by all applicants, free of charge and post free. Applications should be addressed to the Secretary, Ministry of Agriculture, 10, Whitehall Place, S.W.1. The following is a list of the Guides available :—

No. 1. Pig Keeping.
2. Dairy Farming under Smallholding Conditions.
3. Co-operation for Small Producers.
4. The Smallholder's Horse.
5. Farm Crops.
6. Soils and Manures.
7. Fruit Growing on Small Holdings in England and Wales.
8. The Dairy Cow and Milk Selling.
9. Potato Growing on Small Holdings.
10. Market Garden Crops on Small Holdings.
11. Poultry Keeping for Small Holders.

Research Scholarships in Agricultural and Veterinary Science :—The Ministry invites applications for Research Scholarships in Agricultural and Veterinary Science.

Applicants for these Scholarships must be nominated by a Professor or Lecturer of a University or College. Nominations must be received not later than 15th July next, and must be made on the prescribed form to be obtained from the Secretary, Ministry of Agriculture, 4, Whitehall Place, S.W.1.

The Scholarships are tenable for two years and are of the value of £200 per annum. The number to be awarded in the present year will depend upon the qualifications of applicants, and will in any case not exceed five.

The Agricultural Scholarships are open to graduates with honours in Science of a British University who give evidence of high proficiency in subjects having a direct bearing on agriculture. The Veterinary Scholarships are open to students who have secured the diploma of the Royal College of Veterinary Surgeons.

Leaflets issued by the Ministry.—Since the date of the list given on page 1178 of the March issue of this *Journal* three new leaflets have been issued and circulated :—

No. 362.—The Selection, Storage, and Treatment of Seed Potatoes.
„ 365.—Onion Smut.
„ 368.—The Cultivation of Flax for Fibre.

The following leaflets have been revised and brought up to date :—

No. 32.—Foul Brood or Bee Pest.
„ 43.—Titmice.
„ 57.—External Parasites of Poultry.
„ 81.—A Substitute for Dishorning.
„ 88.—Hop Aphis.
„ 156.—Hedgerow Timber.
„ 267.—Basic Slag.
„ 306.—The Goat as a Source of Milk.
„ 307.—The Wood Pigeon.
„ 312.—Blossom-Wilt of Apples.
„ 351.—The Improvement of Village Life.

The following leaflets have been withdrawn from circulation :—

No. 269.—Disease of Raspberry and Loganberry.
Sp. 35.—Transport of Agricultural Produce.
Sp. 61.—The Transport of Agricultural Requisites and Produce.

NOTICES OF BOOKS.

The Annual Report for 1920 and Year Book of the Essex County Farmers' Union.—(Price 2s. 6d. The Secretary of the Union is Mr. John B. Gill, Castledon Farm, Wickford, Essex). In addition to the usual official information this Report contains about forty short articles on matters of general agricultural interest. Among these Sir Henry Rew contributes an appeal for a sense of joint responsibility on the part of employers and employed. Mr. R. Robson and Miss E. W. Jameson collaborate in writing an article on the Insect Population of our Crops, stating a very telling case against frit flies, clover weevils and turnip fleabeetles. Other contributions deal with mole drainage, folding pigs, clean milk, and mushroom growing. The legal side of a farmer's work is provided for by notes on the Seeds Act, 1920, the Fertilisers and Feeding Stuffs Act and the Ecclesiastical Tithe (Rate) Act, 1920. There are over thirty well reproduced illustrations. Farmers in other counties, as well as those of Essex, should find the book distinctly useful.

Practical Dairying.—(Dora G. Saker. London : Methuen & Co., Ltd., 6s. net.) A useful book on Dairying written in a simple and practical style. The book should be of aid to Dairy Students, Farmers and all interested in Dairying. The chapters devoted to butter and cheesemaking are interesting and explicit, and the chapter on cleanliness in the production and handling of milk is worthy of special note.

The Breeding and Feeding of Farm Stock.—(James Wilson. London: Methuen & Co., Ltd., 6s. net.) Dealing in the first chapter with the Stockbreeder's Raw Materials, Professor Wilson gives a most interesting account of the history of British Cattle and Horses from pre-Roman days through the centuries. Prof. Wilson knows his history, and in addition he understands Mendel's Law. Through the application of this law to the records of history he gives a clear outline of the evolution of the modern breeds. With Sheep he has not dealt at such length, and at the present day when the pig occupies such an important place in the economies of Stock breeding it is rather regrettable that he has not dealt fully with the Raw Materials which went to make, and with the methods employed in the making of, modern pig breeds. With cattle and horses, however, the account deals thoroughly and makes interesting reading.

In the second and two subsequent chapters the author discusses the methods of the early breeders, and reviews their work in the light of Mendelism. Much of this had been done in his previous books, "The Principles of Stockbreeding" and "The Evolution of British Cattle," but here in his new book it is put in shorter more concise everyday language, and written in a way which is yet clear and exact, and intelligible to a reader who may have no knowledge of scientific principles.

As in his other books, he is inclined to show favour for the principle of "in-breeding." This question of "in-breeding" is a most difficult one, and if the practice is to be employed at all, it will surely be safe only in the hands of a Master. Bakewell, the Collings, Hugh Watson, were all great masters in their time, but how far will the greatest breeders of the present day advocate breeding in-and-in, or how many of them successfully practise it in its mildest forms with success over any length of period? Professor Wilson repeats again and again the importance of the principle of the tested sire—the importance of keeping the sire till his "class" can be determined from his progeny rather than by his own performance in the show ring, and it is a principle which will bear emphasising.

In the matter of feeding, the Author has made a most exhaustive study of investigations, carried out both on the Continent and at home. In particular he has studied the work done in Sweden and Denmark and thence brings useful lessons for the help of feeders and investigators. Much of this Swedish and Danish work is new to the British reader.

The final chapter is devoted to a useful method of calculating the money value of feeding stuffs, and the book concludes with tables giving the average composition of the common feeding stuffs, and figures showing the comparative feeding value of different foods, or in other words, the number of pounds of each feeding stuff necessary to make a food unit.

Altogether the book is one of the most valuable additions to the animal husbandry side of the agricultural library which has been published. It should find a place on the shelf of every stock breeder and feeder who wishes to probe into problems of breeding and feeding. He will find it a readable, instructive book giving him something to think about and much helpful, sound, practical advice. To the agricultural student and teacher it is invaluable, and embraces a subject sometimes rather inclined to be neglected in favour of the crop husbandry side. In short it is a good book containing a lot of useful, original work.

The Study of Agriculture.—(H. Cecil Pawson. London: Vinton & Co., Ltd. Price 5s. net.) In a small book under above title, Mr. H. Cecil Pawson, Lecturer in Agriculture in the University of Durham, has bridged over the considerable gaps in the information usually available to youths desiring to go in for one branch or another of agriculture. The book should be particularly useful to parents who, though their own pursuits lie in cities or towns, have the desire and means of satisfying their sons' taste for a country life. Of the real difficulty which exists for parents and youngsters alike in getting information and advice on a career that is foreign to them, Mr. Pawson is obviously well aware. Whatever is the final object of training in agriculture, a very big proportion of aspirants are ignorant of the most effective means of arriving at it. The book, however, is not written only for those who, after training, will be in a position to take a farm; it shows also the experience necessary to those who for want of capital or through particular aptitude will tend to become County Organisers, University Lecturers, Research Workers and so on. Within the wide sphere of agriculture many activities lie, and cases could be quoted of intending farmers of seventeen years becoming lecturers at twenty-seven, or of embryo land-agents finishing as officials. It is therefore of the greater importance that the spade work should be such as will qualify for almost any agricultural career, and the foundations must be sound in order to carry the superstructure of later years.

The reading of Mr. Pawson's book will be a revelation to a townsman. The author brings out briefly but clearly the wide nature of the subject, and furnishes a valuable bird's-eye view wherein one can trace the road to success in the different careers that agriculture offers. Practical knowledge must be the foundation of all. How best to acquire that knowledge and preserve it in a systematic way Mr. Pawson aims at showing. It is of the greatest importance for the student to go to a farm, and not only must the farmer be sound but able and willing to explain the business to the newcomer. Cases are met with in which, owing to disinclination or inability on the farmer's part to teach his pupil, the latter frequently learns little beyond the performance of manual tasks. This state of things is not only discouraging to the beginner, but is wasting his time. Like the "Farmer's boy" in the old-fashioned song, the pupil must learn

"To plough and sow, to reap and mow,"

but he is going to be a farmer or a lecturer, as the case may be, and there is much else to learn.

Three rules are given:—"Be observant, willing to learn, and of an enquiring mind." The author demonstrates the value of noting everything that appears important or unusual. He lays stress on the advantage of seeing other farms in the district, and, what is of particular importance to those who desire to attain to official and advisory posts, of gaining practical farming experience in different parts of the country. The time seems to have come when a rising generation of agriculturists amplify their practical experience by attending classes at Farm Institutes or Agricultural Colleges, or go up to a University. It seems that if those interested consulted the authorities of these colleges, not only before entering them, but before starting practical training, a much straighter path might be found to ultimate success. In this stage of the student's career the author has sound advice to

give. It should be borne in mind that the change is very considerable from the wide outlook and open air life on the farm to the steady application of hours of lectures and study. Here the rough but systematised notes of the farming days can be developed into an encyclopædic source of knowledge which will be of lifelong value.

Some readers of Mr. Pawson's book will realise from their own experience that had they been armed with such information when first they took to agriculture much time might have been saved and energy directed into more fruitful channels. If such be the case, the agricultural student of to-day has surely a big pull over his predecessors.

Milk Testing—(C. W. Walker-Tisdale. London: J. North, 3s. 6d. net.) This handbook is prepared specially for practical people to whom quick and reasonably accurate tests are of the greatest importance. It is a concise and practical handbook on milk testing, and contains a number of illustrations and test tables.

An Introduction to Bacterial Diseases of Plants.—(Erwin F. Smith, in charge of the Laboratory of Plant Pathology at Washington: W. B. Saunders, New York. 50s. net.) Most of the knowledge we have of the bacterial diseases of plants has come to us within the last generation. This subject has received much more attention in America than elsewhere. The bacterial origin of Fire-blight of Pear was the first to be discovered by Professor Burrill, of the University of Illinois, about 40 years ago. Since then progress has been slow, and at first doubt as to bacteria being the causal organisms of disease was widely felt.

The greater part of the work carried out in connection with bacterial diseases of plants has been done by Professor Erwin F. Smith, the author of the present work. It is primarily intended for the use of students working in a laboratory under the guidance of a teacher, but it is full of help and interest for all those who wish to have a more complete knowledge of research methods and experimental work in plant bacteriology.

The first part of the book gives a general review of bacterial diseases of plants—their geographical distribution, the susceptibility of plants to these diseases, the causes of their spread, and methods for their control. The second part deals with methods of research, and from the simplicity of the apparatus Professor E. F. Smith uses in his own research it is clear that elaborate apparatus is not necessary for experimental work in bacterial diseases of plants. The third part describes certain bacterial diseases well known in America, namely:—Cucurbit Wilt, Black Rot of Crucifers, Stewart's Disease of Maize, Brown Rot of Solanaceæ, Bacterial Canker of Tomato, Jones's Soft Rot of Carrot, &c., Bacterial Black Rot of the Potato, Bean Blight, McCulloch's Cauliflower Spot, Angular Leaf Spot of Cotton, Mulberry Blight, Fire-blight of Apple, Pear, Quince, &c., Olive Tubercle, and Crown Gall. Part four contains notes on some additional bacterial diseases, and discusses the question of stimuli—chemical and physical—underlying tumour-formation in bacterial diseases of plants. The author argues that his discoveries in connection with tumour-diseases caused by bacteria, particularly Crown Gall, have a profound relationship to animal cancer; the solution of this latter problem he believes to be very near. A few pages at the end of

the book are devoted to general observations on the duty of the scientist from several different aspects.

This book is the result of 35 years of reading and 25 years of diligent laboratory investigation. It is fully illustrated, containing 650 illustrations, which, with very few exceptions, are from the author's own laboratory.

ADDITIONS TO THE LIBRARY.

Field Crops.

Montgomery, E. G.—Productive Farm Crops. (506 pp.) London : J. B. Lippincott Co., n.d. [63.3; 63-3461.]

Commonwealth of Australia : Institute of Science and Industry.—Bull. No. 18 :—A Classification and Detailed Description of the Wheats of Australia. (48 pp.) Melbourne, 1920. [63.311(04).]

Horticulture.

Vilmorin—Andrieux.—The Vegetable Garden. English Edition published under the direction of *W. Robinson*, with an addendum by *W. P. Thomson*. (3rd Edition), (805 pp.). London : Murray, 1920, 25s. net. [63.51(02).]

Dyke, W.—The Science and Practice of Manuring, for the Use of Market Gardeners, Orchardists, &c. (157 pp.) (Revised and Enlarged Edition.) London : The Lockwood Press, 1920, 2s. net. [63.16; 63.5-19.]

Mottet, S.—La Pomme de Terre : Conseils pratiques pour améliorer sa Culture. (72 pp.) Paris : Librairie de l'Académie d'Agriculture, 1920. [63.512(04).]

Rohde, E. S.—A Garden of Herbs. (224 pp.) London : P. L. Warner. [63.348.]

U.S. Department of Agriculture.—Farmers' Bull. 1160 :—Diseases of Apples in Storage. (24 pp.) Washington, 1920. [63.24-41; 63.41(*a*).]

Plant Diseases.

Herrick, G. W.—Insects of Economic Importance. (172 pp.) New York and London : Macmillan Co., 1920, 12s. net. [59.169; 63.27.]

Guénaux, G.—Entomologie et Parasitologie Agricoles. (592 pp.) (Encyclopédie Agricole.) Paris : Baillière et Fils, 1917. [59.169; 63.27(02).]

Chittenden, F. J.—The Garden Doctor. (153 pp.) London : " Country Life " Offices, 1920, 7s. 6d. net. [63.2(02); 63.5(02).]

Dewberry, E. B.—The Prevention and Destruction of Rats. (47 pp.) London : J. Bale, Sons, & Danielson, 1920, 2s. net. [63.269.]

Royal Society.—Reports of the Grain Pests (War) Committee. No. 8 :—I, Bionomic, Morphological and Economic Report on the Acarids of Stored Grain and Flour (Part II), *Prof. R. Newstead and H. M. Morris.* II, Report on the Non-Parasitic or Forage Mites, *Prof. R. Newstead and H. M. Morris.* III, Appendix; Clinical Notes on the Non-Parasitic or Forage Mites, *Capt. W. N. Pillers.* London : Harrison & Sons, 1920, 2s. [63.27-31.]

U.S. Department of Agriculture.—Bull. 887 :—Pear Borer. (8 pp.) Washington, 1920. [63.27-41.]

U.S. Department of Agriculture.—Farmers' Bull. 1176 :—Control of the Root, Stalk and Ear Rot Diseases of Corn. (24 pp.) Washington, 1920. [63.24-31.]

Oregon Agricultural Experiment Station.—Bull. 170 :—The Gray Garden Slug. (43 pp.) Corvallis, 1920. [63.264.]

Veterinary Science.

Louisiana Agricultural Experiment Station.—Bull. 168 :—Anthrax : Transmission of Infection by Non-Biting Flies. (12 pp.) Baton Rouge, 1920. [619.2(*b*).]

U.S. Department of Agriculture.—Bull. 662 :—Vesicular Stomatitis of Horses and Cattle. (10 pp.) Washington, 1918. [619.1; 619.2.]

Live Stock.

Roberts, M. H.—Feeding and Management of Dairy Cattle for Official Production. (294 pp.) New York and London: Longmans, Green & Co., 1920, $3 net. [63.62; 63.711(02).]

Smith, W. W.—Pork Production. With a Chapter on the Prevention of Hog Diseases. (492 pp.) (The Rural Science Series.) New York: Macmillan Co., 1920, 18s. net. [63.64.]

Morton's Handbooks of the Farm.—No. 11, Live Stock. (8th Edition), (156 pp.). London: Vinton & Co., 1919, 4s. [63.6(02).]

Oregon Agricultural Experiment Station.—Bull. 174 :—Fattening Steers. (16 pp.) Corvallis, 1920. [63.62.]

U.S. Department of Agriculture.—Farmers' Bull. 1133 :—Feeding Garbage to Hogs. (26 pp.) Washington, 1920. [63.64.]

U.S. Department of Agriculture.—Farmers' Bull. 1135 :—The Beef Calf: Its Growth and Development. (32 pp.) Washington, 1920. [63.62.]

Montana Agricultural Experiment Station.—Bull. 134 :—Studies on the Digestibility of Sunflower Silage. (8 pp.) Bozeman, 1920. [612.394; 63.604(*a*).]

Union of South Africa, Department of Agriculture.—Bull. 4 :—The Wool Industry. (60 pp.) Pretoria, 1920, 1s. [63.761.]

Dairying and Food, General.

Russell Smith, J.—The World's Food Resources. (634 pp.) London: Williams & Norgate, 1919, 18s. [31; 63 (*o*).]

Savage, W. G.—Food Poisoning and Food Infections. (247 pp.) [Cambridge Public Health Series.] Cambridge University Press, 1920, 15s. net. [612.39; 614.3.]

U.S. Department of Agriculture.—Bull. 890 :—Milk Plant Equipment. (42 pp.) Washington, 1920. [63.713.]

Maryland Agricultural Experiment Station.—Bull. 217 :—The Relation of Milk Yield to Age at First Calf. (11 pp.) College Park, 1918. [63.711(*b*).]

Birds, Poultry and Bees.

Flatt, C. A.—Poultry Keeping. (146 pp.) London: Methuen & Co., 1920, 5s. 6d. [63.65(02).]

U.S. Department of Agriculture.—Farmers' Bull. 1105 :—Care of Mature Fowls. (8 pp.) Washington, 1920. [63.65(04).]

U.S. Department of Agriculture.—Farmers' Bull. 1107 :—Brood Coops and Appliances. (8 pp.) Washington, 1920. [63.65(04).]

U.S. Department of Agriculture.—Farmers' Bull. 1114 :—Common Poultry Diseases. (8 pp.) Washington, 1920. [619.5.]

U.S. Department of Agriculture.—Farmers' Bull. 1116 :—Selection and Care of Poultry Breeding Stock. (10 pp.) Washington, 1920. [63.65(04).]

West of Scotland Agricultural College.—Bull. 96 :—Some Bee Diseases, by *J. Tinsley.* (7 pp.) Glasgow, 1920. [63.81 : 09.]

Engineering.

Breeder's Gazette.—Farm Buildings. (394 pp.) Chicago: Sanders Publishing Co., 1919. [69(02).]

Economics.

Institute for Research in Agricultural Economics.—Miscellaneous Papers in Agricultural Economics, Vol. I., 1913-1918. Oxford, 1920. [338.1.]

Mead, Elwood.—Helping Men Own Farms. (228 pp.) New York: Macmillan Co., 1920, 12s. [331(a); 333.5.]

Ewbank, R. B.—Indian Co-Operative Studies. (266 pp.) Oxford University Press, 1920, 14s. net. [334(54).]

Mees, C. E. K.—The Organization of Industrial Scientific Research. (173 pp.) New York: McGraw-Hill Book Co., 1920. [37(02).]

The Village Clubs Association.—Annual Report and Handbook, 1920. (62 pp.) London: J. Truscott & Son, 1920, 1s. [36.]

Board of Agriculture for Scotland.—Report of the Committee on Women in Agriculture in Scotland. (115 pp.) London and Edinburgh: H.M. Stationery Office, 1920, 5s. net. [331(*c*).]

Printed under the authority of HIS MAJESTY'S STATIONERY OFFICE,
By Metchim & Son, Princes Street, Westminster, S.W.1.

BREEDERS' ANNOUNCEMENTS.

CATTLE.

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